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Some Historical Notes Relative to Governors, and Their Use for Determining the Point of Cut-off in Steam Engines.

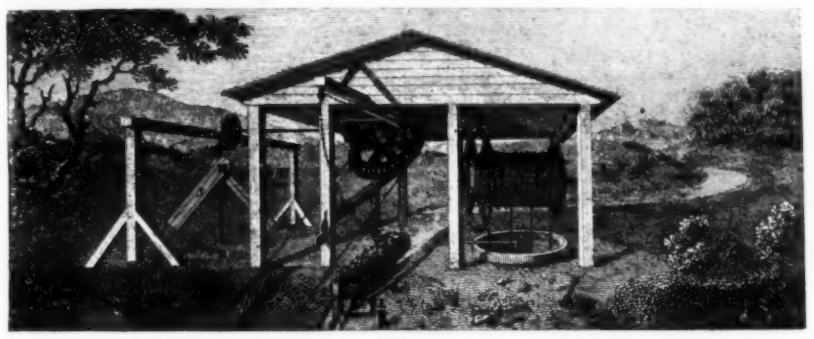
By W. F. DURFEE.

It is a very common opinion that James Watt invented the centrifugal governor, but this mechanism had been in use in corn-mills before Watt applied it to the regulation of his steam engine. In speaking of the irregularities attending the movement of the early engines, Stuart, in his "Descriptive History of the Steam Engine" (1829), says: "A similar irregularity in the motion of corn-mills from the varying quantity of water or resistance, had early exercised the ingenuity of millers, to obtain some means by which its injurious effects could be obviated. One of the most usual modes was by means of a couple of heavy balls, attached by a jointed rod, which were made to revolve by being connected with the spindle or axis of the millstones. When the stones were moving at a great speed, the meal, by the rise of the stones, was too coarse; and on the contrary, when the motion was slow, the meal produced was small in quantity and too fine. The attached balls, which were called a *lift-tenter*, by their centrifugal force either raised or lowered a stage in which the arbor of the spindle revolved, and brought the millstones nearer, or removed them farther from each other, as they might be adjusted. This most ingenious regulator was adopted by Mr. Watt, and applied to regulate the opening and shutting of the throttle valve of his improved engine."

Farey ("Treatise on the Steam Engine," 1827) gives similar testimony. A form of centrifugal governor was proposed by Robert Fulton in 1796. This governor Fulton calls "a pair of centrifugal fans," and he suggests their use for regulating the descent of boats on the inclined planes of his proposed canal. He describes the fans as "composed of wood, and hung to a perpendicular shaft. The object of these is to regulate the movement of the various weights without the attention of the workmen"; . . . . "these fans, as the weights [of the boats] increase in velocity, expand, creating resistance by their action on the air, by which they retard the motion; and although the weight of the boats may vary, they preserve nearly an equal movement." Each blade of these proposed "centrifugal fans" was about 12 feet long and 3 feet wide.

Fulton published in London, in 1796, a treatise on "Canal Navigation," the plates of which were designed and engraved by himself. Fig. 1 is a reduced copy of one of these plates (about one-half the size of the original) in which one method of applying the centrifugal fly fan (seen at *J*) as a governor for regulating the descent of the boats is shown.

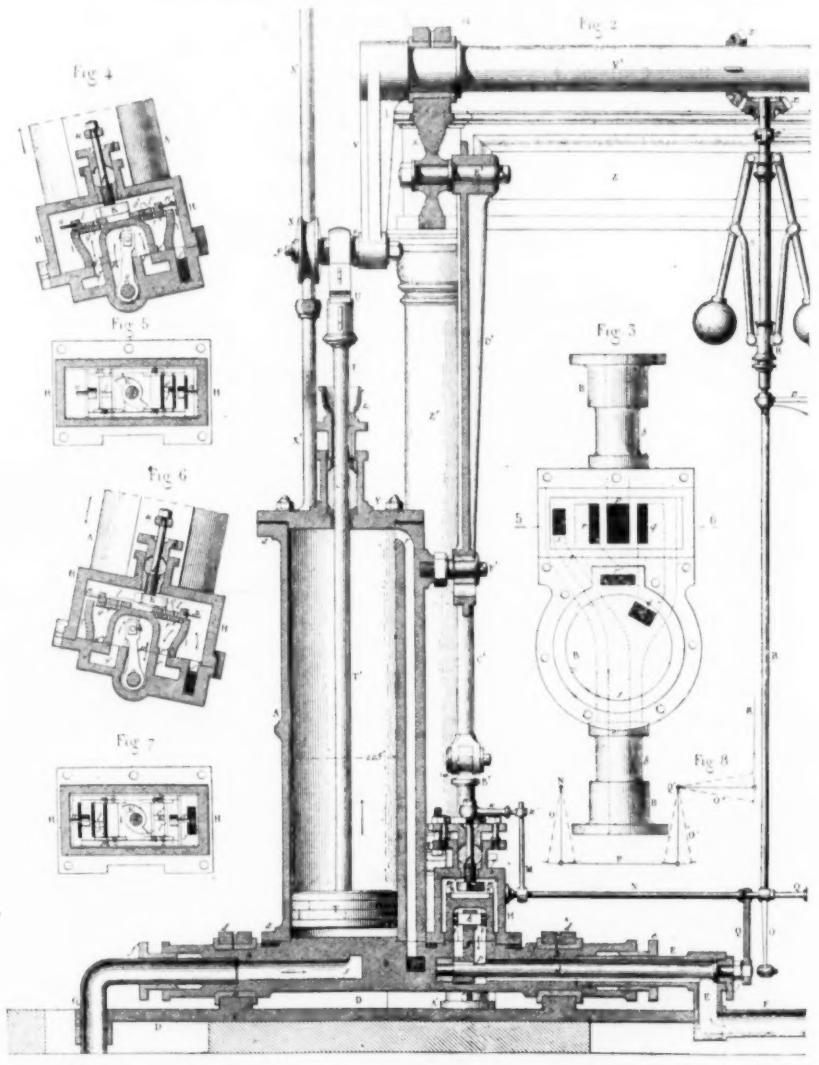
Fly fans were used at a very early day to regulate the unwinding of springs, and the descent of weights, and they are still used in music boxes and the striking parts of clocks; and the movement of a revolving fan acting either on air or a liquid has been employed repeatedly to regulate the motion of steam engines; and the varying pressure upon driving gear or belts, due to the variation of the load upon an engine, has also been applied in a variety of ways to regulate its movements. Vibrating pendulums operating some form of escapement have been used as governors, and, singularly enough, one of the earliest, if not the first, scheme for regulating a steam engine by varying the point of cut-off involved the use of a vibrating pendulum.



ROBERT FULTON'S GOVERNOR, DRAWING AND ENGRAVING.—FIG. 1.

This governor cut-off was invented by Job Rider, a clock and watchmaker of Belfast, Ireland, in 1805. The general idea of this invention embraces a clock-work mechanism driven by a weight which is normally at some little distance below the clock work, and which is continuously wound up by a worm wheel turned by the engine, and allowed to run down by a vibrating pendulum at a certain uniform rate, which is, of course, determined by the length of the pendulum and its consequent number of vibrations per minute. It is therefore evident that if the engine winds the weight up no faster or slower than the pendulum lets it down, that the weight will not move; and, furthermore, that the weight will move upwards or downwards, according as any variation of speed is above or below the established rate.

Such being the behavior of the weight, it is easy to conceive of its movements being used to actuate the trip mechanism of a cut-off valve; but it is just here that the inventor fails to make *his* intent clear; there are no means shown in his drawing for connecting the weight (in fact, the weight itself is not shown) to the liberating motion, and no such motion is depicted; but the description speaks of a lever (that is not visible) as having one end attached to the weight, and the other to the steam valve; and goes on to say, that "while this valve opens and shuts twice at every stroke (?), the lever does not prevent such opening and shutting, but merely limits the extent of the opening by the action of a rod; so that when the weight is highest, the valve is least open, and *vice versa*."



SOME EARLY EXAMPLES OF GOVERNORS.

It is inferable from this description that the governing was to be effected by a combination of throttling and cut-off. The engine, or rather what is shown of it, has four sliding valves, and the cut-off valve is placed in the steam passage—this is also a slide valve in the drawing, but we are told that "the aperture of this valve is formed like an inverted cone." There is no evidence that Rider's idea was ever carried out, or that it had any influence whatever upon the development of the steam engine. Partington, "Historical and Descriptive Account of the Steam Engine," in 1822, described a method of governing, which has been employed in a variety of forms many times. It consists substantially in pumping water (or other liquid) into a small cistern by a pump worked by the engine. In the cistern is a float, and it is provided with a waste pipe, which will, when the engine is running at the proper speed, discharge the water as fast as it is pumped in, but, if the engine runs faster than it should, the water will not flow out of the cistern as fast as it enters, and consequently, the float will rise, and as it is connected with the throttle valve, the steam will be so far shut off as to cause the engine to resume its normal speed.

On October 11, 1832 Richard Roberts, of Manchester, received British patent No. 6,258 for a governor cut-off for steam engines. In his mechanism the governor moved a slide block along a curved rocker arm, and so varied the travel of a "gridiron valve" working on a plate above the main slide valve.

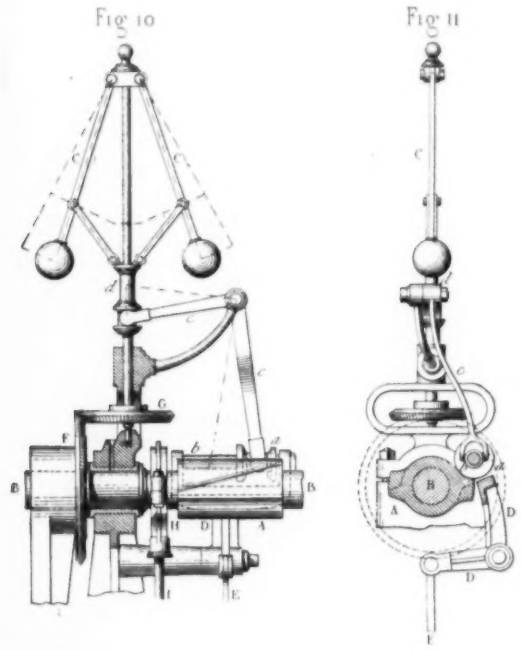
On June 3, 1845, John George Bodmer, of Manchester, received British patent No. 1,043 for an engine in which the expansion was varied, and the speed controlled by a slide valve influenced by the governor. On September 17, 1849, William Hartley, of Bury, received British patent No. 12,547 for a governor cut-off, in which the governor slid a variable cam along a rotating shaft. This idea is believed to have had its origin in France.

Charles Atherton, of Devonport, received on the 7th of February, 1850, British patent for moving an eccentric across a shaft for varying the point of cut-off in steam engines, but he says nothing of the use of a governor for moving the eccentric.

The mechanicians of France were early in the field as inventors of governor cut-offs. M. Farcot received a French patent in 1836, for an oscillating engine having a slide cut-off valve working upon the back of the main valve (see Figs. 2, 3, 4, 5, 6 and 7). In this engine the main slide valve received a definite movement from the oscillation of the cylinder, and the cut-off valve on the back of the main valve received a variable movement, the extent and time of which was determined by the position of the two-

lobed cam *K*, whose position was varied by the governor by means of the shaft *N*, and arms *M* and *u*.

This apparatus could not have made a sharp cut-off, especially on the upper end of the cylinder, but it was perhaps better than no cut-off, and in its day it was certainly approved of in France, for the long, detailed description (in the first volume of *Publication Industrielle des Machines, etc.*, par M. Armengaud, 1841, from which the above engravings were taken), concludes as follows: "M. Farcot has built many similar engines; and has applied his new system of cut-off to a great number of machines of different powers and designs, which he has been commissioned to construct."



EARLY EXAMPLES OF GOVERNING BY CUT-OFF.

In 1847 Armengaud publishes an account of a governor actuated cut-off, invented by M. Frey, "who has been occupied for many years in the manufacture of high-pressure variable expansion engines, on a system very simple and exceedingly economical, both for stationary and oscillating cylinders. The way the mechanism of this variable cut-off operates, is of great simplicity; and has been adopted with more or less modification in a great number of steam engines."

The operative details of this mechanism are well shown (save the valve) in Figs. 10 and 11. They consist of a double twisted-lobed cam *A*, fast on the main shaft *B* of the engine; this cam actuates a spool *a*, which can be moved by the governor, by means of the lever *c c*, along the round bar *b*, supported by the upper forked arm of the bent lever *D D*, to the lower arm of which is connected the rod *E*, which opens and closes the cut-off valve (which is described as an "equilibrium valve") twice for each revolution of the main shaft *B*, the straight sides of the lobes on the cam *A*, opening the valve at the beginning of each stroke, and the inclined sides allowing the valve to close at a point in the stroke determined by the position of the spool *a* on the bar *b*. Such a construction must have lowered rather than dropped the cut-off valve, and therefore the cut-off could not have been a sharp one.

In 1848 Armengaud described an engine built by M. Hallette. This engine is represented by Figs. 12 to 18. It was provided with a governor actuated cut-off valve, which was opened and allowed to close by a cam *P* (Figs. 12, 14 and 15), having twisted lobes, quite similar to those on the cam in the cut-off of M. Frey above described. This cam was secured to the governor shaft, and revolved with it (the shaft revolving at the same speed as the main shaft), and was raised and lowered by the fluctuation of the governor balls. This cam lifted and lowered a Cornish equilibrium valve *S* (Figs. 12, 16 and 17), which was used as a cut-off valve twice in each revolution of the engine, the valve being opened at the beginning of each stroke, and the time of closing being determined by the position of the cam *P*, relative to the roller *O*, which operated the valve *S*, through the medium of the bent lever *N* (Fig. 12). This construction lowered, but did not drop the valve *S* into its seat, and therefore the steam must have been to a certain extent "wire drawn," and the cut-off could not have realized the greatest possible economy.

In the same volume (1848) are described the engines which operated the air pumps of the St. Germain Atmospheric Railway. These were double-cylinder engines 31½ inches diameter and 78¾ inches stroke. Each cylinder had two steam valves (which also acted as cut-off valves) and two exhaust valves, on the side of the cylinder opposite to the steam valves. All of these valves were of the Cornish type; and the steam valves were lifted and lowered by a revolving variable cam controlled by the governor, but the valves were not released from the lifting mechanism and allowed to drop. In none of the above described engines was there a dash pot or any attempt to cut the valve loose from its lifting mechanism, but they serve to establish the fact that the governor had been successfully employed to determine the point of cut-off, many years before Geo. H. Corliss applied it for that purpose to the engine bearing his name; and why some of these instances were not cited in the suits of Sickels *vs.* Corliss, is, to say the least, exceedingly surprising, for it certainly seems that the experts in steam engineering of that time should have been familiar with Armengand's "Publication"; however, as a matter of fact, this use of the governor for regulating an engine through the medium of a cut-off valve, is not the only thing popularly supposed to be original with American designers that is to be found within its pages.

It is not impossible that power-driven bicycles will be common before long.

A New Split Pulley.

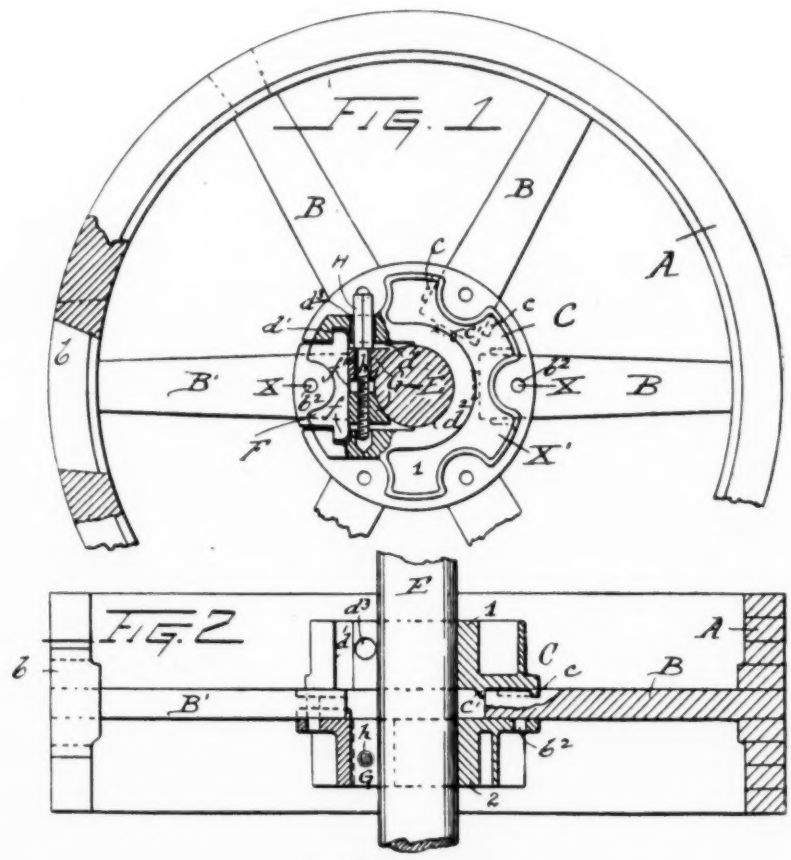
We present herewith engravings of a new split pulley which has been recently patented by Mr. I. M. Hamilton, master mechanic of the Carpenter Steel Company's works at Reading, Pa.

The main portion of the hub of this pulley is made in two parts, which clamp together with the inner ends of the arms between them as shown in Fig. 2, locking the arms securely in place.

At the left of Fig. 1 is shown the construction for opening the pulley to put it on or to remove it from the shaft. The arm *B'*, Fig. 1, is attached to a section of the rim which is removable, and its inner end is clamped between two pieces which are fitted to the opening in the hub as shown, and securely locked against outward movement.

Between the bottom faces of these pieces and the shaft are two wedge blocks which are fitted to the shaft as shown, and are drawn together by bolts in such a way as to clamp the pulley very securely to the shaft without bruising the latter.

The removable section of the rim is dovetailed or otherwise secured in place, and the object of the construction is to secure a substantial pulley easily put on or removed from the shaft.



A NEW SPLIT PULLEY.

Accurate Milling.

BY HORACE L. ARNOLD.

Two very close jobs of milling have recently come to my notice, which go far to show that the milling machine need not in every case be followed by the grinding machine to make work of excellent surface.

The first job is in tool steel; the bars are 10" x 1¼" x ¾", and the limit of thickness varia-

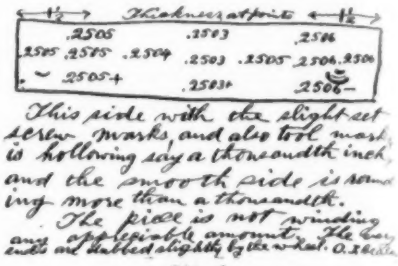

Thickness at print
.2505
.2503
.2506
.2505 .2505 .2504 .2503 .2505 .2506 .2506
.2505+
.2503+
.2506-
This side with the slight set screw marks, and also tool mark is hollowing say a thousandth inch, and the smooth side is running more than a thousandth.
The pick is not winding any appreciable amount. The two ends are rubbed slightly by the wheel. O. E. H.

Fig. 1.

tion is $\frac{1}{1000}$ inch, that is to say, the thickness nowhere measures more than a quarter of a thousandth of an inch out of the way. These were the measurements as given by Mr. Heyer, of the Pratt & Whitney shops, where these pieces were milled.

Fig. 1 gives a slightly differing set of measurements signed by the maker of the record. The piece itself I have left with the editor of this paper, as it marks a step in advance in milling progress. Mr. Beale is, of course, in error in saying that the extreme ends are "dubbed" slightly by the *wheel*, as no grinding wheel ever touched the piece, which has a beautiful surface, and *appears* to have been ground. Mr. Beale asked me if he might be allowed to inquire how the piece was finished, and upon my telling him that it was milled, he said, "and ground?" I replied that the surface was precisely as left by the milling machine, not having been touched by any other agent whatever. Mr. Beale said he would not have believed such a surface could have come from the milling machine.

These pieces are milled five in a bank at once, on a common Pratt & Whitney Lincoln milling machine, of which there are, I think, five or six running on the job, with one attendant, under the charge of Mr. Heyer. Fig. 2 is from my own photograph of the machine without work in it.

Diam. of mill, 2¼". Revs. of mill, 50 per minute. No. teeth in mill, 28. Feed per minute, 1½". Feed per tooth, .00107".

The mill has a spiral cut; angle of

Mr. Wm. Kent, M. E., has been working very hard of late over his new pocket book for mechanical engineers and other matters, and has overworked himself to such an extent as to be banished to Europe by his physician, who tells him to ride through the Rhine country on a bicycle. Mr. Kent sailed the 1st inst.

tooth, 30 degrees. Lubrication, lard oil, flooded.

It will be observed that Mr. Beale's measurements in Fig. 1 make the piece $\frac{3}{10000}$ inch full at its least thickness, and $\frac{6}{10000}$ inch full at its greatest thickness. Mr. Heyer gave me the measurement as a quarter of a thousandth out. Neither Mr. Beale nor Mr. Heyer used anything more accurate than a micrometer in daily use for making the measurements. I myself have not measured the piece at all, preferring to take the measurements of others.

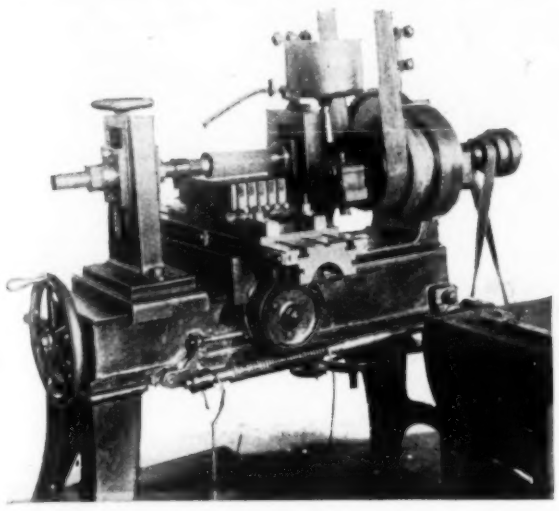


Fig. 2.

As to the hollow and round of the piece, when laid on a surface plate, either side down, it seems to touch all over; but one side up it is not inclined to swing on any point as a center, while the other side up it has a tendency to swing on the middle as a center. I am in doubt as to the piece being nearly so much as $\frac{1}{1000}$ inch out of straight. The application of a hand-held straight-edge to a hand-held piece, by which Mr. Beale determined the curvature, is not a certain method. The piece is, however, certainly not straight, and has a very evident curvature lengthwise.

The finishing of this piece by milling alone reflects the highest credit on every instrument of its production, and, as I have said before, is a step in advance of the previously recognized powers of the milling machine. The surface is without distinct "revolution marks," and, although one side is not quite so good as the other, both sides are better than any unground surface I remember; and the job is proof positive that many milled pieces now finally finished on the grinding machine have one needless handling, as this surface is quite good enough for anything short of scraping or polishing, both in surface and color.

With this excellent work in hand, I called at the factory of the Weston Electrical Instrument Company, 114–116 William street, Newark, N. J., and was at first informed by the vice-president, Mr. Edward Weston, that the place contained nothing of interest to me. The accompanying Figs. 3, 4, 5 and 6 show very conclusively, however, that for at least once in his life, Mr. Weston was not entirely correct as to affairs in his own admirably conducted establishment, where a more elaborate system of detail record is in use than I have previously seen.

Mr. Weston believes fully that such records of shop events can be kept as will give certain success in any new step, provided the lesson of the past is rightly read and followed. The job of 5,000 mild steel pole pieces, all shapes and dimensions of which are fully shown in Fig. 3, was in charge of Mr. D. A. Wallace (Jun. A. S. M. E.), as historian, and his chronology is given in Fig. 3, which is the first compendium of the kind known to me. Mr. Weston very kindly gave an entire afternoon to instructing me in his methods, and I think I speak intelligently, when I say that the art of milling is under great obligations to Mr. Weston's system for accurate information of a class which I have never found recorded elsewhere.

The "pole piece" goes three times through the mills, each time having three surfaces operated upon; thus making nine cuts total. As the piece has six finished surfaces only, it is evident that three of these surfaces must be finished at one cut, while three other surfaces are finished by two operations, one rough and one finishing cut. The two ends of the trough, and the trough cut itself, are those finished at one cut. The end-to-end measurement must be accurate, and is made at one cut. The limit is $\frac{1}{4000}$ inch. The trough cut is refinished by boring in pairs in a two-jawed chuck. It is, however, needful that this important "pole piece" should be as nearly as possible accurate before boring in the lathe as specified. All of the cuts on these pole pieces are made on 3 Brown & Sharpe No. 12 plain milling machines, held in the ordinary vise, and lard oil. The whole of these 5,000 pieces gauge well inside the quarter-thousandth limit. The stock is drop-forged, which may account for considerable individual piece variations in density, yet the greatest average individual weight variation for any day's production is 3 troy grains only. I cannot say that this is the most accurate job of milling ever done, but it is the most nearly uniform of any I ever heard mentioned. Here then we have two extremely good jobs of milling, one done on ordinary tools by Pratt & Whitney, and one done on ordinary Brown & Sharpe tools. The lubrication in both cases is flooded lard oil.

Of the great value of such a sheet as shown in Fig. 3 there can be no doubt; it must lead to constantly increasing shop production where kept.

Mr. Weston thought that $3 per day of 10 hours would amply cover all costs, including the wages of the one attendant for running these three machines. The total time on the 5,000 pieces was exactly 28 days of 10 hours; at $3 per day = $84, = a little less than $0.017, or less than one and seven-tenths cents each for finishing each of the 5,000 pole pieces. Such cost needs no comment.

As to the influence of the 30-degree angle of tooth on the work of a milling machine, I can only say that it seems to leave a smoother surface than smaller tooth angles produce.

Fig. 6 shows a medium Pratt & Whitney machine at work on cast-iron, in the Pratt & Whitney shops, from a very recent photograph of my own. I have no figures for this cut; but have what I consider of value, the statement of the man who had the cut in charge; he said the cut took far less power and was far easier on the feed than if made with a mill of less angle.

So quick a pitch for the mill-tooth angle is either new or so old as to have been forgotten.

NOTES CONCERNING MILLING OPERATIONS

ON STANDARD VOLT-METER POLE-PIECES — 1.0625 BORE. — DRAWING N°530.

PERFORMED SIMULTANEOUSLY ON THREE 12 B&S PLAIN MILLING MACHINES.

WESTON ELECTRICAL INSTRUMENT CO. NEWARK, N. J. — FIVE THOUSAND — FEB. 6TH 1895. — TABULATED BY D. A. WALLACE.

TIME FOR EACH OPERATION	1st Operation	2nd Operation	3rd Operation
CLEANING IN VISE	15 SECS.	15 SECS.	15 SECS.
MILLING	230 SECS.	160 SECS.	200 SECS.
TAKING OUT OF VISE	6 SECS.	6 SECS.	6 SECS.
WHOLE OPERATION	4 MIN. 11 SEC.	3 MIN. 13 SEC.	3 MIN. 41 SEC.

SPEED & FEED DATA FOR ALL OPERATION	Speed N°	Feed N°	Revs. per Min.	Feed per Min.	Feed in one Rev.
CLEANING IN VISE					
MILLING	3	1	84	1/8"	.0148"
TAKING OUT OF VISE					
WHOLE OPERATION					

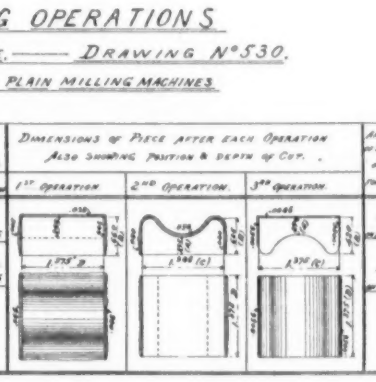
CUTTING SPEED IN FEET PER MINUTE	1st operation	2nd operation	3rd operation
CLEANING IN VISE			
MILLING	SLAB MILL = 52 FT. / SIDE MILLS = 88 FT.	SLAB MILL = 67.7 FT. / SIDE MILLS = 71 FT.	SLAB MILL = 84 FT. / SIDE MILLS = 7 FT.
TAKING OUT OF VISE			
WHOLE OPERATION			

TOTAL TRAVERSE OF PLATEN	1st Operation	2nd Operation	3rd Operation
CLEANING IN VISE			
MILLING	4 1/2"	3"	4"
TAKING OUT OF VISE			
WHOLE OPERATION			

THICKNESS OF STOCK REMOVED. AVERAGE OF 10 PIECES.	1st Operation	2nd Operation	3rd Operation
CLEANING IN VISE	TOP .033	TOP .054	TOP .0045
MILLING	SIDES .046	SIDES .040	SIDES .0056
TAKING OUT OF VISE			
WHOLE OPERATION			

DIMENSIONS OF PIECE AFTER EACH OPERATION ALSO SHOWING POSITION & DEPTH OF CUT.

1st Operation. 2nd Operation. 3rd Operation.



AMOUNT OF STOCK LEFT ON CURVE FOR BORING	
	.009" ON SIDE
	.018" ON PERIPHERY

REMARKS.

JOB ORDER N°1133.

STOCK DROP-FORGED MILD STEEL NOT PICKLED. WEIGHT OF MODEL 1659.7 GRS.

BEGAN HEATING FEB. 6TH 1895

SLAB & SIDE MILLS (DIMENSIONS C.B.A) GROUND FEB 8TH – 9.15 A.M.

1ST CUT. GANG (D) STONED FEB. 12TH 6.00 P.M.

1ST CUT. GANG (D) " FEB 15TH 9.15 A.M.

SIDE MILLS (D) STONED & SET FEB 22 3.00 P.M.

SETTING. REDUCED AVERAGE WEIGHT. 5 GR.

SIDE MILLS (D) STONED & SET FEB 27TH 9.15 A.M.

LAST WEIGHT 1662.3 GRS. – STONING AND RE-SETTING REDUCED WEIGHT TO 1661.3 GRS.

SIDE MILLS (D) STONED & RE-SET MARCH 1ST 9.15 A.M. REDUCING WEIGHT FROM 1663.3 GRS. TO 1663 GRS.

GAUGE LIMIT THROUGHOUT '.0025"

GREATEST AVERAGE INDIVIDUAL WEIGHT VARIATION FOR 10 HRS PRODUCTION 3 GRS. ESTIMATED FROM ACTUAL WEIGHTS TAKEN HOURLY

FLOODED LARD-OIL LUBRICATION

NUMBER OF OPERATION	Weight of Metal Removed. Average of 10 Pieces	Gross Sectional Area of Cut. Average of 10 Pieces	Cubic Contents of Metal Removed. Average of 10 Pieces	Weight of Metal Removed per Min. Acc. of 10 Pieces	Cubic Contents of Metal Removed per Minute.	Area of Metal Removed per Linear Inch of Cutter Face. Slab Mills Only	Weight of P.P. after 3rd Operation	Feed per Tooth. For All Cutters. Side Mills	Feed per Tooth. For All Cutters. Slab Mills	No. of Teeth in All Cutters. Side	No. of Teeth in All Cutters. Slab	Shop Tool Number of Milling Fixture	Shop Tool Number of Gang of Mills
1st Operation	271.8 Grains	.1093 Sqr. Ins.	.1602 Cub. Ins.	70.8 Grs.	.042 Cub. Ins.	.033 Square Inches	Average of 100 Pieces 1663 Grains	.00953"	.00083"	28	18	S.T. N°3480	S.T. N°3487
2nd Operation	343.9 Grs.	.141 Sqr. Ins.	.1939 Cub. Ins.	128.9 Grs.	.073 Cub. Ins.	.054 Square Inches		.00079"	.00134"	20	11	S.T. N°3481	S.T. N°3488
3rd Operation	32.9 Grs.	.01195 Sq. Ins.	.01643 Cub. Ins.	9.6 Grs.	.0049 Cub. Ins.	.005 Square Inches		.00056"	.00082"	26	18	S.T. N°3482	S.T. N°3489

Fig. 3.

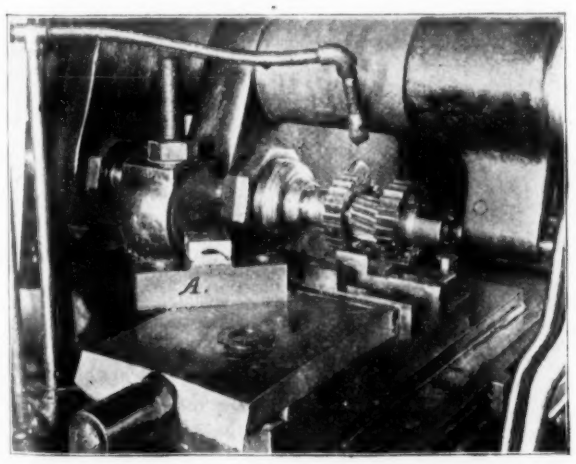


Fig. 4.

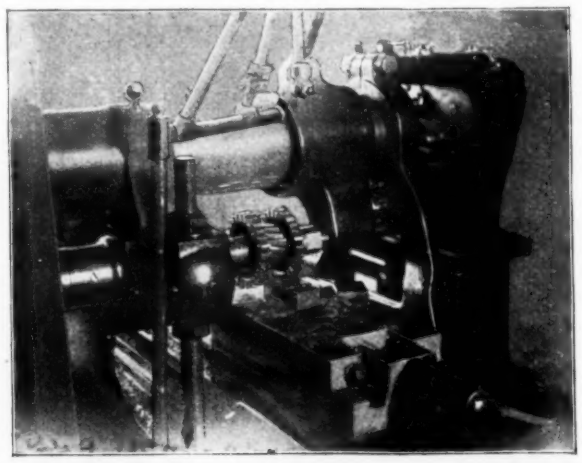


Fig. 5.

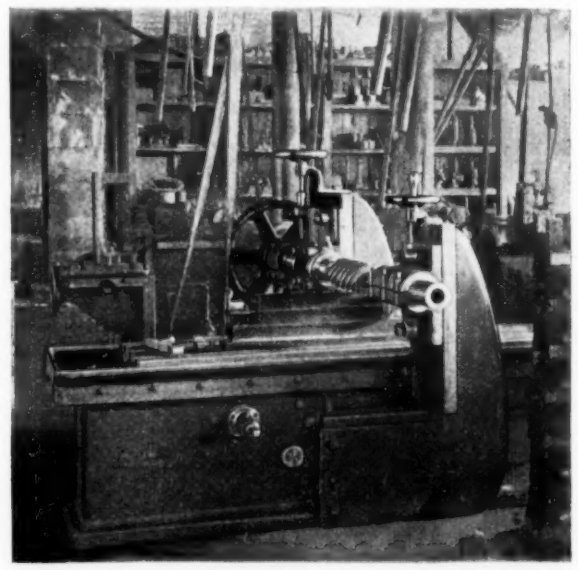


Fig. 6.

ACCURATE MILLING.

Fig. 7 is a machine shop operation on a Brown & Sharpe machine. I give it because it is made without special tools of any sort, either in the way of cutters or fixtures.

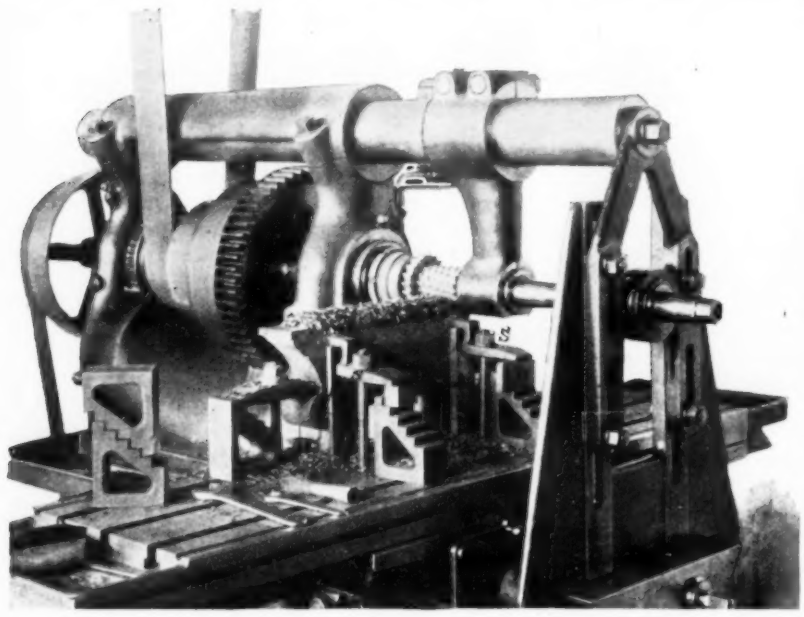


Fig. 7.

The offset straps *S S*, Fig. 7, are simply drawn down on the straight upright straps *A A*, so that their projecting ends can be used as stops or gauges for setting the rough side face of the work.

The figures are:

Diam. large cutter	4″
Diam. small cutter	2½″
Revs. per minute	40
Feed per minute	4⅛″

Feed *with* revolution of mill.

Photograph taken for me at Brown & Sharpe shops. It will be noted that *this* cut is run the "new" way, the mill running onto the work and assisting the feed.

This is an example of what can be done with the milling machine without special tools of any sort. I think the finished surface was about 3 inches wide, and the side was also squared down for ⅜ inch or ½ inch, and the whole cut was made at 4⅛ inches per minute, so that if the piece was 24 inches long the whole cut would be made inside of 6 minutes, or, say, for 2½ cents total shop cost.

The strap blocks shown here in Fig. 7 are of a very handy form for use throughout the shop, on the planer, milling machine or drill press. They are made of rough gray iron, the bottoms only being faced. The hand who had this cut in charge, short as it was in making, was also running another machine.

Punch Press.

We present illustrations of a punch press having the cam adjustment slide connection, etc., of the well-known Stiles' press. It has an opening in the bed 8 inches by 9 inches, and the distance from center of slide back to frame is 8½ inches; extreme distance from bed to bottom of slide 8½ inches. The stroke is 1⅛ inches, but can be made anything from 1 inch to 2 inches, and there is an adjustment of slide of 1¼ inches. The fly wheel weighs 440 pounds, is 30 inches diameter and runs at 150 revolutions.

On a collar of the main shaft is placed a friction brake which is shown in the detail engraving and is seen to consist of a steel collar, open at one side and with helical springs tending to bind it upon the shaft. In the opening, and between two blocks of hardened steel, there is a cam of hardened steel which is operated by the same foot treadle that throws in the clutch, the first effect of the depression of this treadle being to open the brake band and keep it open so long as the treadle remains depressed.

The shaft is 4 inches and the crank pin $2\frac{7}{16}$ inches diameter. The clutch pin is $1\frac{7}{16}$ inches diameter, and the total weight of the machine is 2,000 pounds. It is made by the Fox Machine Co., Grand Rapids, Mich.

Some experience with recent fires has shown that electrical machinery in a power or lighting plant need not necessarily be injured by the destruction of the building by fire more than the steam engine, composing part of the same plant. The large masses of iron now being used in dynamo construction seem able to resist the heat generated by the burning of a light building about as well as a steam engine, and such dynamos have been restored to usefulness after a fire with as little trouble as is usually necessary with an engine.

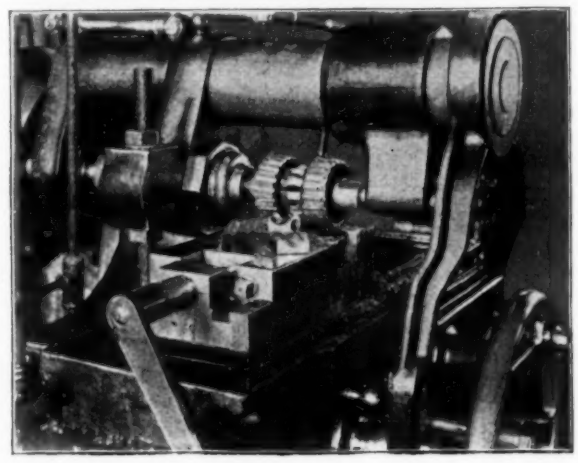
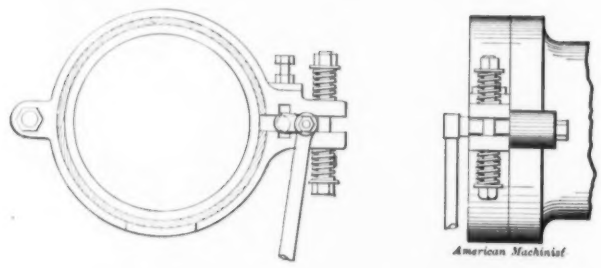


Fig. 8.

Accurate Milling.



Punch Press.

Force, Energy and Power—II.

By P. Lobben.

In the last paper on this subject, which was published in the American Machinist, March 14th, it was explained why we are using the formula, $\frac{1}{2} M V^2$, in calculating the stored-up energy in a moving body, and this will not be repeated here, as this paper is merely a continuation, and we will now see that this formula is very useful in practical calculations of mechanical problems, for instance, in fly wheels. We will, in this, as in the last paper, consider acceleration due to gravity, to be 32 feet, as that will make it easier for a great many of the readers to follow the calculations. If anyone chooses to be a little more scientific and use more refined calculations, the number 32.2 may be substituted, but the results will very seldom, if ever, have any influence in practical problems in fly-wheel calculations.

The object of these articles is to make them as plain as possible, as it is a well-known fact, that to successfully handle any mechanical problem in practical, every-day work, it is far more important to understand the correct principle of the thing, than to be able to make elaborate calculations with half a dozen decimals. Of course some mechanical calculations need great exactness, and decimals must not be omitted. It is quite a difference if the problem is to figure the thickness of a gear tooth at a certain pitch, or if the problem is to figure the stored-up energy in a fly wheel. In the first case, everything and all the conditions of the problem is exactness and almost absolute sizes. In the other problem it is all approximation at the best. By the way, the writer remembers once of a fly wheel calculated—not in the American Machinist—to find the stored-up energy; and the whole weight of the wheel as weighed on a scale, hub arms and all, was considered as revolving in the center of gyration of the rim. Figuring from this base, the acceleration due to gravity was taken as 32.161, and the answer carried out nicely into the third decimal of a foot-pound. Such kind of calculating is worse than useless. We will not figure with such intended refinement, but with refinement enough to be consistent with good legitimate practice and common sense.

First, let us remember, a fly wheel does not add any power, it simply equalizes or regulates the motion of the machinery it is attached to; by giving out under decreasing velocity some of its stored-up energy, and during increasing velocity, absorbing energy. The fly wheel may revolve at a high speed, and the rim may be very heavy, and the change of speed for these reasons hardly perceptible, but it must be a change, no matter how small, before any fly wheel either can give out, or absorb, any energy.

As we have seen the kinetic energy in a moving body increase as the square of the velocity, thus it is plainly seen that it is the rim of the fly wheel that is the most effective. Therefore, under ordinary circumstances, it is customary only to consider the weight of the rim, and to leave the hub and spokes out of the question, as the weight of the metal distributed there is comparatively small, and moves with comparatively slow velocity. For instance, the heft of the hub of any ordinary fly wheel would not, comparatively, have much effect on its regulating qualities, because it is so near the center, and so it is with the arms; they are heaviest towards the hub, where they also move with the slowest velocity. We must remember the velocity increases directly as the distance from the center increases; and the stored-up energy increases as the square of velocity; consequently the stored-up energy must also increase as the square of the distance from the center. Thus we see the error is small, and it is on the safe side, if we leave the weight of the hub and spokes out of the calculation. But, on the other

side, we see it would be a big mistake to consider the whole weight of the fly wheel as acting in the rim. But the inside and outside of the rim do not move with the same velocity either. Which should we base our calculations upon—the inside or the outside diameter? It is customary to figure the velocity according to the middle diameter—a supposed line half-way between the inside and outside diameter—the correct way should be to figure on the radius of gyration which is, $\sqrt{\frac{R^2 + r^2}{2}}$.

R = outside radius,

r = inside radius.

But for ordinary fly wheels having a rim comparatively thin in proportion to the diameter of the wheel, all there is necessary, is to consider the whole weight of the rim (but not the whole weight of the wheel) as moving with a velocity figured according to the middle diameter, or middle radius. Let us now on this basis look at the following problems:

The rim of a fly wheel weighs 2,560 pounds, it has 7 feet 2 inches outside diameter, and 6 feet 10 inches inside diameter, that is, the middle diameter is 7 feet. It is making 150 revolutions per minute. This gives a rim speed per second of $\frac{7 \times 3.1416 \times 150}{60} = 54.98$ feet, or practically 55 feet per second. What is the stored-up energy?

$$E = \tfrac{1}{2}\ M\ V^2.$$

$$M = \frac{2,560}{32} = 80 \text{ and } \tfrac{1}{2}\ M = 40.$$

Thus we have $E = 40 \times 55^2 = 40 \times 55 \times 55 = 121,000$ foot-pounds stored-up energy. If during short intervals, when machinery is thrown on, the fly wheel is slacked up to a rim speed of 51 feet per second, how much stored-up energy will it then have given up to help drive the machinery? Just as much as the difference in energy due to the difference in speed. The stored-up energy at 51 revolutions is $E = 40 \times 51 \times 51 = 104,040$ foot-pounds, or in other words, the fly wheel has, during this change of speed, given up to the machinery $121,000 - 104,040 = 16,960$ foot-pounds of energy.

This change of speed is more than would be allowable in most kinds of machinery. It is over 7 per cent. It would change the number of revolutions from 150 to $139\frac{1}{11}$ revolutions per minute, in order to allow this fly wheel to part with 16,960 foot-pounds of energy.

Suppose we would not allow the speed to decrease so much, then we must either increase the weight of the fly wheel or its rim speed. Let us see which is the most practical. Making the wheel twice as heavy, or 5,120 pounds, and running at the same speed, we have stored-up energy $E =$

$$\frac{5,120}{32} \times \tfrac{1}{2} \times 55 \times 55 = 80 \times 55 \times 55 =$$

242,000 foot-pounds. Suppose now, same as before, that the machinery absorbs 16,960 foot-pounds when it is thrown on. To how much will this reduce the velocity of the fly wheel? $242,000 - 16,960 = 225,040$ foot pounds. Using the formula $\frac{1}{2}\ M\ V^2 = E$, we have:

$$V^2 = \frac{225,040}{80}$$

$$V^2 = 2,813$$

$$V = \sqrt{2,813}$$

$V = 53$ feet per second.

This rim speed of 53 feet per second, corresponds to $144\frac{6}{11}$ revolutions per minute. But suppose, instead of doubling the weight we were doubling the rim speed by doubling the diameter of the fly wheel. What would then be the result? We will now let the rim of the fly wheel (same as originally) weigh 2,500 pounds, but we will make the middle diameter 14 feet, instead of 7 feet. This gives a rim speed of 110 feet per second (probably a little faster than is advisable in some fly wheels on account of the strain due to the centrifugal force).

$$\text{Stored-up energy} = \tfrac{1}{2}\ M.\ V^2$$
$$= 40 \times 110^2$$
$$= 484,000 \text{ foot-pounds.}$$

If the machinery, same as before, in starting, draws from the fly wheel 16,960 foot-pounds of energy, how much will this reduce the speed of the shafting? $484,000 - 16,960 = 467,040$ foot-pounds of energy left in the fly wheel, and the speed due to this is found by the same formula.

$$\tfrac{1}{2}\ M\ V^2 = E.$$

$$V^2 = \frac{467,040}{40}$$

$$V^2 = 11,676$$

$$V = \sqrt{11,676}$$

$V = 108$ feet per second (very nearly).

This corresponds to $147\frac{8}{11}$ revolutions per minute of the shafting. Thus we see it is a far more effective remedy to increase the rim speed than to increase weight, and it is also far more economical, as doubling the weight of the fly wheel will almost, also, double its cost, but doubling its diameter ought not to increase the cost but little. And we see this point is taken advantage of in some machinery, for instance, in gas engines and petroleum engines. They always give the impression that their fly wheels are excessively large compared with the engine, but this is a good point, and ought to be taken advantage of in many other kinds of machinery, as this is only to construct machines in accordance with natural laws.

This must not be understood to the effect that the writer is advocating to run cast-iron fly wheels at a rim speed of 110 feet per second. The speed of a fly wheel must be limited according to its strength, and according to how much it could be possible for the speed to increase, accidentally. A high factor of safety must be allowed, and it must never be lost sight of, that centrifugal force increases as the square of the velocity (this will probably be considered in a further paper) neither must anyone construe this article as saying that doubling the weight of a fly wheel and doubling its rim speed has the same effect, as it is plainly shown by these calculations that increasing the rim speed is far the most effective. For two different fly wheels to be equally effective, at the same velocity, the weight of the rims must be in inverse proportion to the square of their diameters.

Thus a fly wheel 10 feet middle diameter, and 500 pounds of rim, is just as effective at the same number of revolutions per minute as another fly wheel that is 5 feet middle diameter, and 2,000 pounds weight of rim.

For $10^2 \times 500 = 50,000$, and $5^2 \times 2,000 = 50,000$.

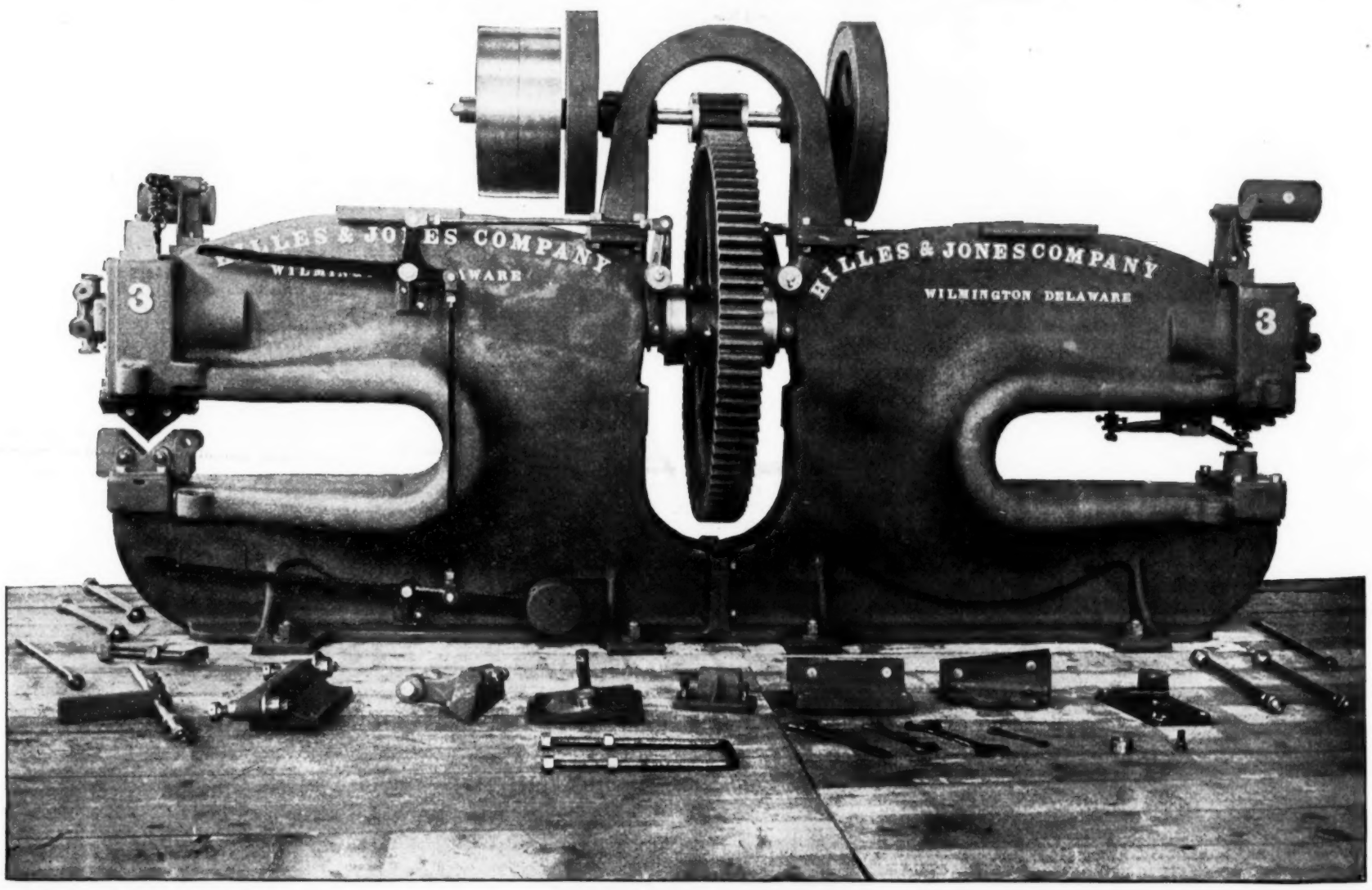
Combined Punch and Shears.

The accompanying illustration is of a combined punching and shearing machine, with 48 inches depth of throat, and with a capacity for punching a 1-inch hole in 1-inch iron, shearing ¾-inch plate.

The two ends of the machine can be worked entirely independently of each other so that two gangs of men can be employed upon it, if desired.

The outfit, as shown in the illustration, consists of one punch and die for center of nose (in position for heavy duty with adjustable stripper), one extra cast steel die block for small diameters of die for punching angles, flanges, etc., one pair of knives and knife blocks with holding-down clamp for cutting off angles in position on the shear end, one pair of knives and knife blocks for trimming plates, with holding-down clamp and a bevel shearing attachment.

The size of the nose is 9″x17″, with a clearance hole for dropping out punchings 6½ inches diameter. The tool is well adapted for punching out hand or tube holes up to its capacity. The sliding heads are counterbalanced through spiral springs, and have taper brass shoes for taking up wear. There is a line of these machines which includes a large number of this general type for either heavier or lighter duty. It is built by the Hilles & Jones Co., Wilmington, Del.



Combined Punch and Shears.

At first sight, it would seem as though the plan of attaching a hook to the foot stock of a heavy lathe, said hook being intended to engage with the carriage so that the foot stock can be moved upon the bed by the movement of the carriage, is a very good plan, but when it is considered that it is often quite necessary to move the foot stock, when for various reasons the carriage cannot be moved at all, the value of the device seems to shrink somewhat, and the little additional expense of a bracket supporting a shaft and pinion to engage the feed rack is seen to be better.

LETTERS FROM PRACTICAL MEN.

Index for Grinding Gear Cutters.

Editor American Machinist:

Nearly all the cutter grinders that have been illustrated in your paper have an indexing arrangement for grinding gear cutters, by means of a tooth rest or index finger that comes in contact with the back of the tooth being ground, which method insures all the teeth being of the same thickness, but not necessarily all the cutting points at the same distance from the center of the hole, as many cutters get somewhat out of round in hardening, as may be learned by inspecting the holes.

Having a job of gear cutting not long ago that needed to be pretty nice, I devised the gauge shown in Fig. 1 to test the gear cutters to see if all the teeth were the same distance from the center of hole. I had no regular cutter grinder, but ground the cutters on a cast-iron disk covered with emery cloth, running in an ordinary emery grinder, and used the gauge to see which teeth to grind and which not to grind. I think the principle of the thing is O. K., but the details might be improved upon, as the gauge shown was made of the nearest things the scrap box afforded. Fig 2 shows the body

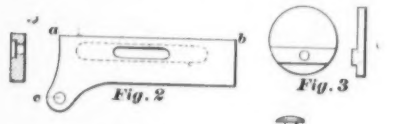


Fig. 2

Fig. 3

Fig. 5

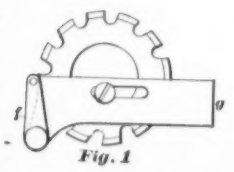


Fig. 1

Fig. 4

of gauge in elevation and section. It is of sheet brass and has a shallow groove milled in one face in which fits the tongue of Fig. 3. This tongue is so located that when the parts are together the center of the disk coincides with the edge *a b* of the body. This disk fits the hole in cutter, and is made adjustable horizontally to accommodate cutters of different outside diameters. The link, Fig. 4, is hinged to the body by stud, Fig. 5, which fits tight in hole *c* and loose in hole *d*. The pin *e* comes in contact with the end of the body when the points *f* and *g* are grasped tightly between the thumb and fingers of the left hand; then the cutter may be rotated with the right hand till the relieved part of a tooth strikes pin *e*, and the front face of the tooth compared with the radial edge *a b* by simply sighting across this edge. By slightly releasing the grasp of the left hand and then tightening again, the tooth in contact with pin *e* may be allowed to go by, and the next one examined, and so on all the way around the cutter, noting the teeth that stick up the most above the edge *a b*, and grinding these only. By alternate grinding and comparing with the gauge the teeth are soon brought all to one hight, the disk, of course, being adjusted in its slot in the first place, so that none of the teeth fall below the edge *a b*. In addition to showing any difference in hight of the teeth, this gauge will also show if the front faces are ground radially, which is an important item, as the teeth will not cut their own shape when ground in other than a radial plane.

Before making this gauge I used to grind only those teeth that were dull, as it is the teeth that are farthest from the center that get dull the most, and if there are some teeth that don't cut they naturally don't get dull, and therefore need no grinding. This is a rather primitive method of grinding cutters, but will produce fairly good results if persevered in.

I think the method of indexing from the relieved part of the tooth is much better than using the back of the tooth for that purpose, and have no doubt it could be applied with good results to many cutter grinders now in existence.

WALTER GRIBBEN.

An Emery-Wheel Dresser on a Grindstone.

Editor American Machinist:

We set up a new grindstone a few days ago. The stone had lain around several years. When started up we found it to be elliptical, running out nearly half an inch. I usually turn the grindstone with a piece of small pipe on an old round file.

In this case the stone was too hard. It would reduce the pipe one quarter of an inch and the file an eighth in a revolution of the stone. After several failures I took a Huntington emery-wheel dresser and fastened a bar of iron across the frame, and in ten minutes the stone was true.

Decatur, Ill. W. A. BRIGHT.

American vs. Foreign Lathes and Other Tools.

Editor American Machinist:

In regard to the question respecting the relative value of English and American machine tools, it seems to me that both kinds of tools are good, and both are bad. The Englishman excels perhaps in simplicity of general form, together with superior weight, strength and stiffness. He has not, however, learned to incorporate in his products that convenience in matters of detail which tends to rapid and easy manipulation.

The American, on the other hand, excels in little conveniences of all sorts, and has produced tools which in many cases will beat the world for rapid and easily understood manipulation. He, however, fails (as he always has) to make his machinery strong enough, heavy enough, and stiff enough—still following the "fiddle" rather than the "anvil" as his model of construction, although, it must be confessed, not so enthusiastically as he did a few years ago. Instances of such frail and vibratory construction are everywhere about us. Not fifty feet from where I sit, I can find a Yankee-made lathe with a tool slide some 5 inches wide and 4 inches high, cored out inside, to save two or three pounds of cast-iron. A little farther down the shop is a lathe built somewhat after the alleged English style, with everything apparently rather chunky, and doubtless intended by its maker to be a standing reproof to the wicked Yankees, who are supposed to make everything so flimsy. One of the features of this machine is an extremely heavy upright member at the right end of the headstock, which looks as if it would splendidly support the spindle above. A little investigation, however, shows that this is cast hollow, its walls being, perhaps, ¼ inch thick, with the result of having saved some 20 or 30 cents' worth of cast-iron to the man who sold it for a sum not far from $300. In view of such melancholy facts as these, I can only go on preaching, as I always have, that what we need is *all the iron we can get in* for the stationary parts of our machine tools, and a reasonable increase in the amount of the same in the moving parts, so far as such is consistent with the anti-clumsiness necessary for rapid manipulation.

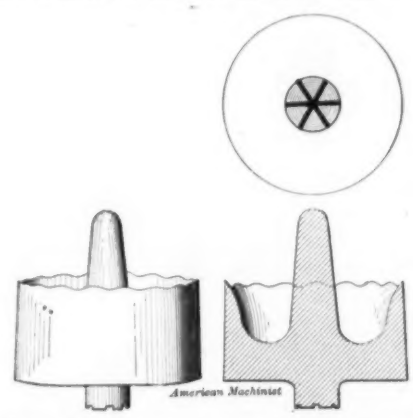
The best simple reform that could now be made upon the great majority of American lathes and drill presses would be to *reduce their swing to one-half* of the present amount, while retaining the present total weight, and keeping their beds about as wide as now. In like manner, the planers, while remaining as heavy as they are now, should be reduced in width and hight between columns to somewhere about two-thirds of the present measurements. That spindles should be increased as much as possible, and that the total driving power should be very considerably augmented, especially upon drill presses, is, I think, a self-evident fact.

OBERLIN SMITH.

A Paper Weight for Draftsmen.

Editor American Machinist:

In making temporary drawings, hasty sketches, studies, in scheming out the parts of a system to arrange them in consonance, it is an advantage to lay a piece of paper on the board, and set a shift on it, to hold it in position. I use the word "shift" as a term to designate a weight which can be readily shifted about from one place to another. It is handier to hold the paper in this way than to have to tack or glue it. Paper weights have been made in an infinite variety, and many forms for this especial purpose. The shape shown in the cuts has some advantages. It is convenient for one thing. The cuts represent it in plan, section and perspective. These which I refer to are 2½ inches in diameter. They stand on a small base ⅛ inch diameter, which is ⅜ inch high. The body of the weight spreads out above this, but does not interfere with the



blades of the squares which pass under. Notice that the center of gravity is low down; they are not easily upset. Two of them will hold the paper, three is better, and four is enough. Those scallops on top are not for pride, but to keep anything from rolling off, that is laid on them, as, for instance, instruments or pencils. They are easily molded from a solid pattern, in iron, and all the finish they need is plain japanning.

TYRO.

Weight and Mass.

Editor American Machinist:

The two letters in your issue of March 28th, on the subject of "Weight and Mass," one signed "Anti-Know-All" and the other "Bell Crank," determined me to try to say something on this subject which should help to give a clearer idea of it. In the first place, the first named of these correspondents has misunderstood the application of the law that the attraction of a hollow spherical shell (due to its mass) for any body within it, is balanced in all directions for all positions of the body, and is therefore practically zero.

This means that if the earth were a hollow shell, a body inside it would be subjected to forces which were exactly balanced, and so if it were placed within such a shell, without initial velocity, it would remain stationary wherever it was put.

As a matter of fact, however, the earth being solid all through, what would happen if a body were dropped into a hole going to its center and straight through, would be that, supposing the earth a perfect sphere without surface irregularities, it would start at the surface under the action of the attraction due to the whole earth, but as it fell toward the center it would be balanced as regards a shell of a thickness equal to the distance it had passed at each point, and would therefore receive at each instant the attraction of a sphere whose radius was equal to its own distance from the center of the earth at that instant, the attraction being less and less as it approached the center, and finally becoming zero at that point. But this does not at all imply that it would remain at rest there, for having a high velocity and being balanced as to outside forces at that point, it would go straight on through with a velocity decreasing just as it had previously increased and coming to rest at the surface on the other side of the earth, only to start back again and repeat this process forever, unless interfered with by some other influence.

This supposes that there is no air in the hole, or any other matter whatever, for "Anti-Know-All" is, of course, correct in his supposition that the resistance of the air plays a very important part in this matter, and where it is of importance to get the real result, it must be very carefully estimated from such laws as the scientists have been able to discover upon the subject. It is said that the effect of the resistance of the air is so great that a bullet which would penetrate a two-inch oak plank if fired into it at the muzzle of the rifle, would only dent it if it were fired vertically into the air and struck the plank at the end of its descent, while its velocity (and consequently penetration) would be just the same in either case if the air offered no resistance. Somehow, I have never cared to try this experiment myself.

As to the distinction between weight and mass, it is a very difficult one to make, and can, I think, best be gotten at by considering a spring balance and a given piece of matter, say, a standard ten-pound weight. Now, the *mass* of that piece of matter is constant as long as nothing is taken from the weight or added to it, for mass is, by definition in works of science, "quantity of matter."

Now, if the weight and the spring balance are both correct, the balance will register ten pounds when the weight is hung upon it, *if it is in latitude 45 degrees and at the level of the sea.* If, however, it is taken to the top of a high mountain under the equator, the balance will indicate less than ten pounds, because the weight will be considerably further from the center of the earth and because the centrifugal force opposing the attraction of gravitation is greater there, while if taken to the pole the balance will indicate a greater weight than ten pounds for opposite reasons.

The general law of the attraction of gravitation is that it acts upon every two particles of matter in the universe, and with a force proportional to both their masses (that is, to the product of their masses) and inversely proportional to the square of the distance between them.

The weight of any body is simply the attraction of the earth for the body, and would be constant wherever the body was taken if the earth were perfectly spherical and had no motion of rotation on its axis.

With this correction, therefore, the weight of any body is proportional to its mass; and at the same point on the earth's surface, the mass or quantity of matter in any two bodies is proportional to their weight.

We have seen, however, that the weight of a given mass does change even on the earth, and if it were possible to go to the moon or the sun, we should find more startling differences, for on the moon our balance would only indicate about one pound (I believe) while at the sun we should not be able to lift the weight at all, and should be crushed ourselves by the intensity of the attraction of so great a body.

"Bell Crank" asks why it is necessary to divide weight by g in order to obtain mass, also by supposing different units of measurement of length shows that the numerical value of mass changes, and wishes to know what the trouble is. It is simply that we have no absolute measure for mass, and can only get at it by the fact I have spoken of above, that, except for small corrections, mass is proportional to weight, and as we use the foot, pound, second system of measures, it is most convenient to use that mass as a unit, which acted upon by a force of one pound for one second, will acquire a velocity of one foot per second, and, as a force of one pound acting upon the mass contained in a one-pound weight, gives it a velocity of 32.166 feet per second at the end of the first second, the mass contained in a weight of 32.166 pounds, if acted upon for one second by a force of one pound, would receive a velocity of one foot per second; therefore with this system weight is 32.166 times mass, or $\frac{\text{weight}}{g} = \text{mass}$. In other words, this is only a convention or general agreement, and in any other system would be different, as, for instance, in the metric, where g is a little less than ten (meters).

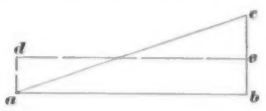
The really essential point in it all is the law that the moving force divided by the acceleration produced in one second is *proportional* to the mass, and if we wish to say that it is *equal* to the mass we must choose our measures to fit the facts, or having given for the measure of force that required to overcome the attraction of gravitation upon a pound weight and the unit of length, as the foot, in order to say $\frac{\text{weight}}{\text{acceleration}}$ *equals* mass, instead of saying *is proportional*

to mass, we have to make mass 32.166, or g times the weight.

"Bell Crank" makes a mistake in giving the formula force + velocity = mass, it should be force + acceleration = mass, acceleration being the velocity added by the force acting through one second. This is a very important distinction.

In the solution of "Bell Crank's" problems we will suppose that the force to move the sled is uniform, and therefore the acceleration will be constant, that is to say, in each hundreth (or other part) of a second the velocity of the sled will be increased by just the same amount as in any other hundredth, that is, the velocity starts at zero and increases uniformly, so that the velocity would be represented by the distance vertically up from the line $a\ b$ to the line $a\ c$, where distance along $a\ b$ is proportional to the time.

Now the *average* velocity of the sled is to be one foot per second; since it is to move



one foot in one second, and we know that the average hight of the triangle $a\ b\ c$ is one-half of $b\ c$, that is, the velocity at the end of the first second will be twice the average velocity, or two feet per second, and since the velocity has increased from zero to two feet per second, in one second the acceleration will be two feet per second by the definition of acceleration.

Now, in our formula we have mass = $\frac{1}{32.166}$, acceleration = 2, and force = $2 \times \frac{1}{32.166} = \frac{1}{16.083}$ pound.

Similarly for the second problem the acceleration is four feet per second and the force $\frac{1}{8.04}$ pound.

The formula for centrifugal force is $\frac{\text{mass} \times \text{velocity}^2}{\text{radius}}$, and in the problem given would be simply $\frac{1}{32.166}$, since v is one and r is one.

J. E. JOHNSON, JR.

Longdale, Va.

The Proper Method of Projection.

Editor American Machinist:

I have made it a practice not to write for the AMERICAN MACHINIST unless I had something new to communicate, but in the present instance I make an exception, because what I have to say is not strictly new, but a record of opinion, or rather vote upon the mooted question of projection.

I may be said to belong to the first-angle school of draftsmen, though I use the third angle when, for obvious reasons, it seems preferable, and I sometimes use both in the same drawing. However I make them I always make sure that there can be no possible misunderstanding as to the direction in which each view is taken; and of the hundreds of drawings that I have made during the past few years, I do not remember a single instance in which one of them was misunderstood in this particular.

My preference for the first-angle method may be prejudice, but I am unable to recognize it as such. One reason for placing the elevation above the plan is that the elevation is usually the first view made, and it is easier to make the plan with the elevation in front of me, than when I am leaning over it and have it covered up with my T-square and triangles. Another reason is that with the elevation above I am not rubbing dirt into it when I am making the plan, and a third reason is that when I look at any object I look *down* to see the *top* unless I happen to be standing on my head, which isn't very often.

I quite agree with Mr. Halsey that I would not put the front elevation of a locomotive against the tender, nor the rear elevation alongside of the pilot. But let us suppose that instead of a front elevation the view is a section just back of the smokestack, showing the inside of the front head. Would Mr. Halsey put that behind the tender for the purpose of maintaining the third-angle method? Perhaps he would, but I doubt it. My own practice would be to put that view next to the pilot and the front elevation next beyond. Of course, when the object is a long one, as in this case, if the section was not wanted I would omit it and move the front elevation next to the pilot. But in the great majority of cases I find that a section is much more important than an end elevation, and I treat every section (and, in fact, every drawing) as a *view*, and every view as a *picture*, that represents the thing as it would appear when looked at. Following out this idea, if I make a sectional view looking to the right, I place that view in the direction in which I look, that is, at the right, and if I made a second view on the same section line looking toward the left, I would place that second view at the left. In other words, I cut the elevation in two and open it up precisely as I would open up a book before my face. If anyone doubts the simplicity and plainness of this, let him imagine how the pages of the AMERICAN MACHINIST would look if he opened it up on the third-angle method of projection.

As far as convenience for the draftsman goes and ease of making drawings, I know absolutely no difference between the two methods of making projections, and in each particular case use my judgment in choosing that which will be most readily understood. The relatively great importance of sectional views over end elevations, and the idea of treating all drawings as views that show things as they appear, incline me to prefer the first-angle method for all cases where there is not some strong reason for the contrary.

C. L. REDFIELD.

A Doctored Show Casting.

Editor American Machinist:

In a recent number you suggest that it is difficult to judge of the quality of foundry work by seeing the product of a "paint" shop, or words to that effect. To this I beg leave to add, that it is equally difficult to judge of the quality of foundry work, after the work has passed through the machine shop, but has not yet been through the paint shop. I can go even further, and say, that a machine-finished "show casting" need not bear any evidence that it was ever in a machine shop at all. Forty years ago, my "old man" set me to finishing a 3-inch flat-bottom journal box, *all over*, for a "show casting," the requirements being that the *runners, risers and sand scale* should be retained intact.

The finishing of the 3-inch journal box, so it looked as if just from the foundry, was as follows: The uncleaned castings were taken to the shop, where the runners were cut off, leaving stumps about 1½ inches long, and the riser (on the bottom casting only) protected by a close wrapping of twine. Fitting together, boring, turning, chipping and filing followed. Then scraping to take off file marks, and stoning with oil to take off scraper marks, were in order. Next came boiling with potash, to take off the oil; sweating in a charcoal fire, to take off the "machine finish;" washing in dilute acid, to take off the "fire finish," and rubbing with a woolen cloth, to take off most, but not all, of the acid, and the castings were ready to receive the coat of scale. Dilute white shellac was applied and dusted with burnt foundry sand. This was repeated until the scale was thick enough to suit the general conditions of the foundry practice.

In a few days the remaining acid got in its work, the scale began to fall off, and the finest specimen of foundry work ever made was ready for exhibition. I did not invent this process, and therefore may say that those specimens would have deceived Tubal Cain himself, had he lived long enough to have seen them.

SUPERANNUATED.

American vs. English Lathes.

Editor American Machinist:

I have been much interested in the recent letters and articles on the above subject. Having had a pretty extensive experience for some years past, in a shop running an equal number of both types, perhaps the result of my observations may be interesting to your readers. I have no prejudice in upholding one or the other, but believe that each is superior in certain conditions, and the sooner we British manufacturers get more tools better suited to our work, the better for us and the country at large. Where they come from is a secondary consideration. In my opinion the raised Vees or ways for the saddle and head stocks are indispensable where accurate work has to be done, and far superior to the flat beds in use here. Another excellent feature is the arrangement of the apron and geared feed to saddle, with all the handles in just the right place for convenience in operating without any fooling with a spanner. These characteristics, which are fully appreciated by the workmen, and the general handiness of the thing, place the American lathe in the front rank, when the amount of metal to be removed is small or frequent changes are necessary. For heavy cuts, I prefer the English lathe, with its rigidity—and clumsiness, if you like—for the simple reason that it is capable of doing more work in a day. Judging from Mr. E. A. Muller's remarks on the subject, I am prepared to hear that I am wasting good material. I can only say that "I know what I want, and get it the cheapest way I can."

Professor Sweet is quite correct in his remarks on the difference in the cast iron in use here and in America, a fact which probably accounts for some differences in design of the tools. Such a letter as that of your correspondent, Mr. A. B. Lawther, can do no good, but may please a few suffering like him from an ebullition of "national feeling." There are lots of lathes built here with the sole object of being sold at the lowest possible price, and bought by firms who should know better. These lathes, however, by no means represent English practice, any more than some productions I have seen over here represent American. Is it not a fact that American machine tools of all kinds are being built heavier all the time?

AN ENGLISH SUPERINTENDENT.

A Screw Thread Without an End.

Editor American Machinist:

Certain parties at Milwaukee managed to wiggle out a model for a double-threaded screw, which has been the cause of a great deal of worry and bother, not only to the home talent, but to machinists and shop clerks all over the country. In fact, it has been on the steady go for the last four months, accompanied with stamps and tag, indorsed "please return with estimates."

The best that Milwaukee could hatch was "$200 for 'designing' a machine to cast those screws." This looked really cheap after they received a bid from one of the largest and best-equipped shops in the States to "make a machine for $1,400, and $600 for the first 500 screws."

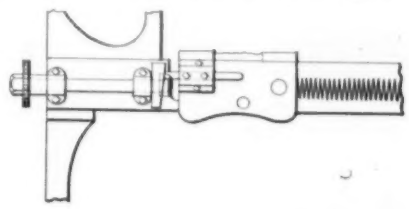
Fig. 1.

Before these figures had had an opportunity to keep me awake nights, I had the foolhardiness to offer to rig up "something" for that screw for $50, but one look at them was enough to make me crawl out in as good a shape as possible, and we settled on a compromise—that they should pay for the time, and we do our best.

The screw in question is shown in Fig. 1. It is $\frac{5}{16}$ round aluminum bronze 2⅝ inches long, and on this is cut a continuous right and left square thread, $\frac{1}{32}$ inch wide and deep, seven threads to the inch.

We had an old forsaken engine lathe, which had gone through the various stages of abuse as tapping machine and wood-boring machine, and had then been chopped nearly in two to give room for a 6-inch larger face plate, and do service for pattern-making.

We removed the lead screw with brackets, and made a new set of brackets with 4 inches space from center of hole to bed, and screwed them onto the bed below the head 12 inches apart. On the outer end we fitted the feed gear, and on the other a cam 7 inches diameter, and with an incline of 1¼ inches, which is the extreme length of thread from end to end. On the slide rest we fixed another bracket with a ¾ round steel rod, adjusted with set screws. To the right of slide rest is a coiled spring 3 feet long of ¼ inch steel wire, which gives a



steady pressure on the slide rest up against the cam. We geared the lathe up 20 to 1, spindle making 2,000 to the cam, 100 revolutions, and the tool, although necessarily very slim, cut it like cheese, at the rate of 700 a day. After the job was done, it was so easy that we did not get the $50 for it.

P. D.

A New Grease Cup.

We illustrate a new grease cup, recently brought out by the Penberthy Injector Co., Detroit, Mich., which cup seems to have points of superiority essentially its own.

The grease is contained in a glass cylinder,

protected by a brass shell with four openings showing at all times the contents of the cup, and only carelessness can let it run empty, and the journal run dry. The plunger for forcing the grease is a heavy rubber washer, protected on both sides by a brass disk, and all so attached to the central stem that it is free to turn without turning the plunger, and still allow no grease to pass the center of the washer. The body of the cup is screwed to the shank, and is removed from the shank to be refilled, so that the cover need never be removed, and none of the parts can be lost or mislaid.

American coal-cutting machines are being rapidly introduced in Europe. In one mine in Saxony, with an increase of 59 machines, over a half million more tons of coal were produced. Machine methods, increasing the output capacity, relatively decrease the percentages of standard charges. Of the coal cutters employed, all American, the Jeffrey (electric), and the Harrison and the Ingersoll (compressed air) gave the highest results.

The Franklin Institute, Philadelphia, Pa., has published in book form a sketch of its organization and history, compiled by the secretary, Wm. H. Wahl. This history contains a great many interesting points regarding the origin and development of an organization which has exerted an important influence upon the development of mechanical arts in this country. We are not informed as to the terms upon which it can be obtained, but these can be learned by corresponding with the secretary.

The President of the French Republic has conferred the cross of the Legion of Honor upon M. Martin, the chief engineer of the French steamship "La Gascogne," in recognition of his services in bringing his steamer safely into port when the engine broke down during a voyage to this port last January.

AMERICAN MACHINIST

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NEW YORK, MAY 9, 1895.

CONTENTS.

	PAGE.
Some Historical Notes Relative to Governors, and Their Use for Determining the Point of Cut-off in Steam Engines. By W. F. Durfee..	361
A New Split Pulley	362
Accurate Milling. By Horace L. Arnold	362
Punch Press.	364
Force, Energy and Power—II. By P. Lobben..	364
Combined Punch and Shears	365
Letters from Practical Men: Index for Grinding Gear Cutters. By Walter Gribben....An Emery Wheel Dresser on a Grindstone. By W. A. Bright....American *vs.* Foreign Lathes and Other Tools. By Oberlin Smith....A Paper Weight for Draftsmen. By Tyro.... Weight and Mass. By J. E. Johnson, Jr.... The Proper Method of Projection. By C. L. Redfield. ..A Doctored Show Casting. By Superannuated... American *vs.* English Lathes. By An English Superintendent....A Screw Thread Without an End. By P. D.	366, 367
A New Grease Cup	367
Foreign Trade	368
Some Phases of the Patent Question	368
Death of Franklin Fairbanks	368
Literary Notes	368
Questions and Answers	369
Compressed Air versus Electricity. By Frank Richards	369
New Steamship for the "Red D" Line.	371
Manistee Improved Steam Pump	371
A Remarkable Armor Plate	371
The Acme Standard Screw Thread	371
The Westinghouse Brake Abroad	372
New Catalogs	372
Manufactures.	372
Machinists' Supplies and Iron	373

Foreign Trade.

Our English contemporary, *The Ironmonger*, has been making an investigation of the status of British hardware and kindred lines of trade in foreign countries as compared with what other countries are doing in the same fields. In its treatment of the subject our contemporary speaks of "Foreign and American Competition," signifying, we take it, that American competition is regarded as far more formidable than that of any other one nation. An examination of replies to questions sent out by *The Ironmonger* fully justifies this view of the case, and shows that in hardware and other manufactured articles, the product, directly or indirectly, of our tool makers, we are rapidly assuming a leading position and, in fact, have already attained it in many lines.

It is, of course, self-evident that we Americans have very much to learn regarding export trade in manufactured articles, and we cannot urge too strongly, perhaps, the importance and the necessity, in fact, for our learning it as rapidly as possible. It is as plainly evident as anything still in the future can well be that American machinery and goods manufactured by its use will go abroad in increasing quantities as their merits become better understood. Some certain builders of such machinery and manufacturers will get this trade and will be greatly benefited by it, especially during the inevitable commercial depressions such as we are just emerging from, and it is largely within the power of every manufacturer to decide for himself whether or not he will be amongst the number.

We can safely predict that those American machinery builders who found themselves at times during the recent depression doing more work for export than for home trade will leave nothing undone that will enable them to retain and develop foreign trade.

There ought to be this summer a good deal of foreign travel by American machinery builders and their representatives. We know from the evidence of our own foreign correspondence and rapidly growing foreign subscription list that there is an increasing interest among manufacturers of other countries in American machinery, and this should be taken full advantage of. Iron and steel are now about as cheap in this country as in any other, and actually cheaper than in some others, while our skilled labor, though paid more money per day, in most cases is not materially if at all higher in cost when the amount of its product is considered.

In fact it is well-established that labor costs per pound or per piece are in many lines of manufactured goods and machinery less here than elsewhere for the same quality. This condition will inevitably lead to an increasing foreign trade, and the wise machinery manufacturers are recognizing this fact and preparing to get their share of the business.

Some Phases of the Patent Question.

Referring to our recent remarks about patents, the manager of a large manufacturing concern writes:

"We are also interested in the articles regarding patents. Our experience has been that in the light the courts now seem to regard patents, they are worthless. We have spent considerable money to sustain patents, and have finally thrown the whole business up. We will not fight a patent case, pay a lawyer a dollar for anything in connection with one, or pay anything but a nominal price for a patent, unless we are forced to. We do not, however, consider that this course is conducive to the development of inventive genius, and regret that the courts will not sustain patents stronger on *prima facie* evidence. We think there is more chance of injustice being done, by the inventor having to prove the validity of his patent, than there would be by making the infringer prove that he is not an infringer."

Though the attitude assumed by this concern toward patents is an extreme one, those who have opportunities to know the sentiment of manufacturers regarding patents, are aware that there is a growing distrust of them—a feeling that while patents as interpreted by the courts are less and less a protection to real inventors and manufacturers of patented devices, they are more and more a protection to those who are not real inventors, and who derive direct benefit from these laws only because their spirit and plain intent are violated. How much justification there may be for this feeling we cannot undertake to say, but the recent severe condemnation of certain practices in the Patent Office by the government itself, speaking through the judicial department, is significant, and the people generally know that many abuses have been and are being carried on under the protection of patent law as interpreted by the courts; and when such a conviction is formed in the minds of the people, they are too apt to overlook entirely the good features which go far toward or entirely overbalance the evil ones.

Something illustrating this last unfortunate feature of the case is seen in the above quoted letter; where the idea is advanced, that it would serve the ends of justice better if, in infringement cases, the burden of proof were thrown upon the alleged infringer. This would be reversing the well established rule of law, and would be virtually holding the accused to be guilty until he could prove himself innocent. It is needless to point out that such a reversal of legal principle would be revolutionary and extremely dangerous—might, in fact, easily work more harm to society and civilization than would the entire abandonment of our patent system, valuable as we believe that to be.

It is well to note, however, that our correspondent has his wish so far as very many infringement suits are concerned; such, for instance, as those wherein the practical identity of the infringing, and of the patented device is apparent or acknowledged and the alleged infringer must, by proof of prior invention, or use, break down and nullify the patent, in order to successfully defend himself.

Nothing is more certain than that our patent laws need some revision; and, if a committee composed of inventors, manufacturers, lawyers and statesmen, appointed for the purpose, could agree upon a revision of them, and have their views adopted by Congress, it would be a very desirable thing. The greatest obstacle to doing this is probably the sentiment of opposition to the entire patent system, which has grown up, in many quarters, as a result of its outrageous abuse, combined with deplorable ignorance of the subject.

In conclusion, it seems proper to say that the skillful drawing up of specifications and claims for a patent is no trifling matter. It should not be intrusted to anyone who comes handy, nor to those who grind them out by machine methods, with a force of irresponsible and ignorant clerks to do the work.

More careful selection of patent attorneys, and a more general recognition of the fact that more and better paid talent should be employed in the preparation of patent applications, would go very far toward removing some of the causes of dissatisfaction with the patent system.

The latest perpetual motion scheme has its head center located in Newark, N. J., and seems to be entirely in the hands of a company of Italians. The inventor of this latest machine of its class is Michael Patrano, who is set down as an Italian mechanic, and to judge from the newspaper notices he is able to secure, and the amounts of money said to have been paid in to enable him to develop his invention, he has some ability in other directions, at least, whatever may be said of his ability as a mechanic.

Newspaper items announcing increases of wages are very numerous just now, the advance in the cotton manufacturing industry having been followed by similar advances in other lines. One of the latest announcements is of an advance of 10 per cent. to the molders of Cleveland, the result of a strike which lasted only one day and appears to have been easily settled. In many cases the advance in wages is nothing more than a restoration of the scale paid previous to reductions made within the past year or two, but it is to be hoped that business will continue to improve until a general increase of wages will become a necessary part of the general advance. This will mean that the masses of the people are prosperous, and their prosperity is an essential requisite to any real progress of society in right directions.

The English naval authorities have lately discovered that bilge keels not only are a useful adjunct to prevent excessive rolling of steamers, but that a ship so fitted will turn in less space than otherwise, and that there is no sensible reduction of speed by reason of the slight increase of friction surface. Bilge keels have been in use in the U. S. Navy for many years, a number of the old wooden gunboats having been fitted with them years before the advent of the modern ship that has no sail power to steady her.

Death of Franklin Fairbanks.

Franklin Fairbanks died at his home in St. Johnsbury, Vermont, on April 24, 1895, in his 67th year. He was the youngest of four sons of Erastus Fairbanks, Governor of Vermont, and founder of the famous scale works to which he gave his name. Franklin lived all his life and died in his native town. He entered the scale works at seventeen, and became a practical mechanic. He was made a partner in the works January, 1856, and upon the incorporation of the company in 1876, became vice-president being also the superintendent, and on the death of his brother Horace, assumed the presidency. Colonel Fairbanks does not seem to have been a great inventor, although he had several patents which went into use all over the country, the most noteworthy perhaps being the revolving beam for letter balances, adopted by the government, and used in most of the post offices in the United States. In 1880 he went to San Francisco to set up a testing scale of his own invention for the government. He was the friend of his men, taking an active interest in their welfare, and was respected and beloved by them. By his arrangement the works were closed from the time of his death until after the funeral, with no loss of wages to the men, and his remains were carried from the church to the grave by old employes of the company, as was also done at the funeral of his father. Colonel Fairbanks gave to his native town a fine museum of natural science.

Literary Notes.

MOTIVE POWERS AND THEIR PRACTICAL SELECTION. By Reginald Bolton.

In this book an English engineer, who, however, has spent much time in this country and has had much to do with the selection of prime movers for a wide variety of purposes and to work under widely varying conditions, has purposed to set down in plain statements and figures the leading considerations that will influence a choice in any given case. He acknowledges to begin with that in very many cases the choice, if rightly made, must be made by an engineer, yet thinks that a compilation of the facts and considerations that go to settle such a matter will prove useful, not only to engineers, but also to others, and especially in cases where a choice must be made by those on the spot without the advice of a competent engineer. In every case the cost of the apparatus discussed is given in English and United States money as nearly as possible. The preparation of the numerous tables and data has evidently involved a very great deal of work by the author, and we think the book will be found quite useful to those who have occasion to balance considerations for and against different types of prime

movers, though it is, of course, evident that no book of 252 pages can cover the whole subject—it can only help, and this we believe the book will do. It is published by Longmans, Green & Co., New York. Price, $2.25.

The Tradesman, Chattanooga, Tenn., has compiled a census of the cotton-mills of the Southern States, and has procured data separately for each mill. It finds that the whole number of mills completed and in the course of erection is 372, and the growth of the industry is shown by the fact that in 1890 there were in the 14 Southern States 1,699,082 spindles, and 38,865 looms; whereas now there are 3,001,340 spindles, and 70,874 looms; showing an increase in spindles and looms of nearly 100 per cent. in the five years. Since June, 1894, it is claimed there has been an increase of about 100,000 spindles, and 1,500 looms.

We have received from Cornell University, Ithaca, N. Y., a pamphlet containing a paper by Professor Thurston, entitled "The Needs and Opportunities of a Great Technical College." These are clearly and comprehensively set forth, and the pamphlet will be found of interest.

One of the latest new periodicals is called *The Mogul*, and is devoted to railroad matters. It is published by Wm. Wyler & Co., Lock Box 11, Dover, N. J.

We have received from the publisher, Effingham Wilson, Royal Exchange, E. C., London, England, a book devoted to the silver question, and its injury to British trade and manufacturers. The book contains a paper by Geo. Jamieson, Esq., and others, and will probably assist in throwing light upon this vexed question. Its price in England is 6d.

We have received from the passenger department of the Northern Pacific Railroad Co., St. Paul, Minn., a copy of a book called "Sketches of Wonderland." In this are many fine engravings of a section of the country, the beauties of which are little appreciated by most Americans. The book will prove especially interesting and attractive probably to those of the Mechanical Engineers' party who returned from California by that route. The book can be obtained by forwarding 6 cents in stamps to Charles S. Fee, General Passenger Ticket Agent, St. Paul, Minn.

Questions and Answers.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet. We cannot undertake to answer questions in "next issue." This department is usually crowded, and questions must wait their turn to be answered. Neither can we undertake to solve mechanical or engineering problems, and send answers by mail.

(185) M. D. B., Westfield, N. Y., writes: Please inform what to use to reduce mica to pulp. *A.*—We know of no other way than to grind it to a fine powder, and then mix it with such liquid as will be suitable for the purpose for which the pulp is to be used.

(186) M. C. J., Buffalo, N. Y., asks: Am I right in believing that the producer gas used in large works, mentioned in your issue of January 10th, is produced by heating coal or coke in retorts in the usual way, only heating to a higher degree, and dispensing with all purification processes? *A.*—You are right, with one exception, coal only, and not coke, is used.

(187) E. E. P., Jeffersonville, Ohio, asks: Which is the strongest kind of steel? *A.*—Steel which contains about one per cent. of carbon has probably the greatest tensile strength. 2. Which is the strongest kind of wood? *A.*—Lancewood has the greatest tensile strength. 3. I have read in some paper that there is a kind of wood as strong as steel; is this true? *A.*—We have not met with a wood of this kind. Your other questions are so indefinite that they cannot be answered.

(188) A. M. C., Peterborough, Canada, asks: What is the greatest number of miles ever traveled by a railroad train in one hour? 2. In what time was the fastest mile ever made on a railroad? Please give authentic or reliable answers to the above. *A.*—We have made inquiries, and conclude that it is impossible to answer these questions with any degree of correctness. There is no authentic data in existence which will give the required information.

(189) S. C. W., Lancaster, Pa., writes: I have a three horse-power gasolene engine, its charge is exploded by a red-hot tube. I want to change this to an electric igniter. About how many cells will I require in the battery, and whose make do you consider best suited for the purpose? *A.*—We cannot undertake to recommend any particular battery. Any dealer in gasolene engines will furnish you with a complete outfit for an electric igniter.

(190) E. B. J., Brooklyn, N. Y., writes: Kindly give the title of the latest and most complete mechanical engineer's text-book, also name of publisher. *A.*—"The Constructor," by Professor Reuleaux, and "Elements of Machine Design," by Professor Unwin, are the latest books published for the use of mechanical engineers. These you can obtain from any dealer in scientific works. Although these books are as complete as any which have been published, mechanical engineers require a great many other books.

(191) Arguer, Chicago, Ill., asks: In what ratio to speed does the frictional resistance of a revolving shaft vary, atmospheric resistance not considered? *A.*—If there is no change in the pressure on the journal, and no change in the lubrication, the frictional resistance will vary directly as the speed. 2. Does the top part of a carriage wheel move faster than the bottom? *A.*—With reference to the ground, the top of the wheel moves faster than the bottom; with reference to the axle, the velocities of the top and bottom of the wheel are equal.

(192) C. H., Brooklyn, N. Y., writes: We make wire specialties of No. 13½ wire, and in forming the articles they become hardened, so that we have to anneal them, and after that they have to be coppered. What I want to know is, is there a way of brightening them without tumbling them, as this bends them out of shape? Any light you can throw on this subject will be appreciated. *A.*—The following method of cleaning for coppering the wire may answer your purpose: Place the article for a short time in dilute sulphuric acid, consisting of about 1 part of acid to 16 parts of water. Then wash the article in water, and scour with sand till the surface is perfectly clean.

(193) W. B. M., writes: What metal or combination of metals can I use for the bearing of a small lathe running at a very high speed and used for burnishing? I wish to avoid the use of a lubricant, if possible, because I find where oil is used on the bearing it gets into the water used in the buffing operation and gets onto the work, interfering with the process. Is there a plan by which water might be used as a lubricant for the bearing? *A.*—We should try a ball bearing or roller bearing, and these could, we think, be lubricated by water, but, of course, would not run quite so well nor wear so well as if lubricated with oil. We should think that by skillful designing a journal and box could be arranged, which would absolutely prevent the lubricant from mixing with the water.

(194) L. C. K., Landisville, Pa., writes: I have an 8¼-inch by 20-inch engine carrying 80 pounds boiler steam at 120 revolutions. What is its horse-power and what would be its horse-power if the stroke was shortened to 14 inches? *A.*—Your engine is developing about 29 horse-power (exhausting into atmosphere assumed), and with a 14-inch stroke would develop about 20.3 horse-power with same speed and boiler pressure. This assumes that the cut off is with an ordinary slide valve. The scheme is perfectly practical, although the short stroke will consume somewhat more power in friction than if the cut-off was made closer to reduce the power to the required limit, and the cost of the new crank will probably much more than offset the expense of necessary valve adjustment to cut-off for the lessened power.

(195) R. L., City, asks: Why do builders of duplex steam pumps use such short strokes? Can you give me a rule to find the proper point of stroke at which the piston of a duplex pump should pass the exhaust port in order to cushion properly? *A.*—A short stroke pump enables the valve motion levers to work through a less angle than would otherwise be possible, and also shortens the total length of pump. The piston should cross or shut off the exhaust at such a point of stroke as will properly consume the momentum of piston, rods, and column of water. This latter factor is a complicated one to determine, as a great deal depends on the general design, and experience alone can properly determine the cushion work that can satisfactorily take care of it, and your best procedure would be to follow practice that has been proved satisfactory. No *rule* would be of any service.

(196) F. M., Chicago, Ill., writes: Please give me a comparative value of graphite, babbitt metal and brass for bearings as used in heavy machinery, light running machinery, and in pounding machinery. *A.*—A comparative value of these materials cannot be given, they are chosen in accordance with individual judgment and experience, and sometimes the first cost of the machinery will have something to do with the choice of the material. Graphite is used for lubricating purposes in heavy machinery, and brass enters the construction of bearings to far greater extent than babbitt metal in this class of machinery. For light running machinery graphite is not suitable, babbitt metal is used to a great extent, particularly for bearings of line shafting; brass also is used in the construction of some of the bearings in this class of machinery. For bearings subjected to pounding, brass is far more suitable than babbitt metal.

(197) N. O., Hoboken, N. J., writes: Please give me a rule for finding the weight of a fly wheel for a gas engine. *A.*—Divide 48,000,000 by the square of the diameter in feet of the fly wheel, and by the square of the number of revolutions per minute; multiply the quotient by the area of the piston in square inches, and by the stroke in feet, the result will be the weight of the rim in pounds. Expressing this rule in symbols, we have

$$W = \frac{48{,}000{,}000}{D^2 \times R^2} \times A \times S,$$

in which W = weight of rim of fly-wheel in pounds, D = diameter of fly wheel in feet, R = number of revolutions per minute, A = area of the piston in square inches, and S = stroke in feet. The weight of rim found by the above rule is for a gas engine in which the charge is fired at each alternate revolution. In cases in which the charge is fired with every revolution, one-half the weight as found by the above rule will be sufficient. It must also be understood that when two fly wheels are used, the above weight is the sum of the weights of both rims.

(198) A. S., ——, writes: Please give me a rule for computing the force which a drop hammer will exert under the following conditions: The weight of the head is 600 pounds; it falls through a hight of 9 feet, and compresses a piece of cold iron .015 foot. *A.*—First find the velocity of the head at the end of the fall of 9 feet by the following rule:

$$v = \sqrt{2 \times a \times s}, \qquad (1)$$

in which v = velocity in feet per second, a = acceleration due to gravity less frictional resistance, say, 28 feet per second, and s = hight, in feet, through which the head falls. Substituting in formula (1) these values for the letters, we have

$$v = \sqrt{2 \times 28 \times 9} = 22.4 \text{ feet}.$$

Now, the stored-up energy in foot-pounds at the end of the fall is equal to

$$\frac{W \times v^2}{64.4} = E, \qquad (2)$$

in which W = weight in pounds of the head, v = velocity of the head as found above, and E = stored-up energy. Hence we have

$$\frac{600 \times 22.4^2}{64.4} = 4{,}674.782 \text{ foot-pounds}.$$

This energy is expended in traveling through a distance of .015 foot; hence the average force of the blow will be

$$\frac{4{,}674.782}{.015} = 311{,}652 \text{ pounds}.$$

(199) E. J., Brooklyn, N. Y., writes: Please give a rule for computing the strength of a hollow cast-iron pillar 12 feet long, 7 inches outside diameter, and 6 inches inside diameter. Also give a rule for finding the diameter of a solid cast-iron pillar which will support the same weight as the above hollow pillar. *A.*—The breaking load of hollow cast-iron pillars with flat ends firmly fixed can be computed by the following formula:

Breaking load =

$$\frac{\text{Metal area} \times 80{,}000}{1 + \dfrac{\text{Length}^2 \text{ in inches}}{800 \times \text{Diameter}^2 \text{ in inches}}} \qquad (1)$$

Which reads: Multiply the cross-sectional area of the metal in square inches by 80,000, call this product A. Multiply the square of the outside diameter in inches of the pillar by 800; call this product B. Now square the length in inches of pillar and divide this by quotient B, and add 1 to the result; call this the sum C. Lastly, divide the product A by the sum C, the result will be the breaking load of the pillar. For finding the diameter of a solid cast-iron pillar which will support the same load as found by the foregoing formula, use the same rule but leave the metal area out of the computation, the result will be the load per square inch. Divide the breaking load as found by formula (1) by the load per square inch, and multiply this quotient by 2, the result will be the cross-sectional area in square inches of the solid pillar, from which the diameter is easily found. 2. Please give a rule for computing the velocity of steam flowing through an orifice in a boiler, pressure of steam being given. *A.*—Steam of any pressure flowing through an opening into any other pressure less than three-fifths of the initial, has practically a constant velocity of 888 feet per second.

Business Specials

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear Wheels, Gear Cutting. Grant; see page 372.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Cam-Milling. Machine Tool Works, Newark, N.J.

Marine Iron Works, Chicago (new catalog).

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 157 William St., N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Best Presses and Dies for all sheet metal work, Ferracute Machine Company, Bridgeton, N. J.

70 Uses of Compressed Air mailed free. Clayton Air Compressor Works, 28 Cortlandt street, N. Y.

Engine Castings, 1 to 6 Horse-power Vertical. The Humphrey Foundry, Bellefontaine, Ohio.

Foster Engineering Co., Newark, N. J., Pressure Regulators, Reducing Valves, Pump Governors.

Gardenier's "Ready Help for Locomotive Engineers." Price by mail, $1.00. Edward Meeks, publisher, Philadelphia.

Squaring and Rotary Shears, Tinsmiths' Tools, Presses and Dies for sheet metal work, are made by the Niagara Stamping and Tool Co., Buffalo, N.Y.

Machine work solicited; complete equipment modern machine tools; patternmaking, designing, experimental work; tech. assistance if required; best facilities & very reasonable prices. P. Pryibil, 512-524 West 41st St., N. Y.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 post paid. Published by John Wiley & Sons, 53 East Tenth street, New York.

"Modern Locomotive Construction." By J. G. A. Meyer. In this book the design and construction of all details of the locomotive and tender are considered from a practical standpoint. It contains illustrations of details made from working drawings, accompanied by plain directions for designing, and rules and tables for construction. Adapted to office and shop use. Price, $10. Published by John Wiley & Sons, 53 East Tenth street, New York.

Compressed Air versus Electricity.

BY FRANK RICHARDS.

The title of this article is adopted in deference to the prevalent idea of the relations of these two power transmitters. To our thinking, the "*versus*" should be read as lightly as it is possible to read it, for there is in fact but little antagonism or competition between compressed air and electricity, and there is little likelihood that in practice there ever will be. Neither of them is a power transmitter pure and simple, as a wire rope may be said to be, but is each capable of performing other functions, and the power-transmitting capabilities of each, in combination with their other individually peculiar lines of usefulness, open for each a distinct and separate field, which neither can fill for the other. The same is true of some of the other power transmitters. They each have their special fields of usefulness, which neither of the others could fill as well, if at all.

Those of us who were so fortunate as to be able to attend the April meeting of the Mechanical Engineers in New York, were impressed with the able, clear and forcible presentation of the promises of the gas engine in the line of power development, transmission, and distribution, and its enthusiastic advocate closed with a sweeping prediction that before long the gas engine was going to supersede every other motor over a field that would be practically bound-

less. But only a few minutes later in the progress of the meeting it was made to appear that not the gas engine but the oil engine is *the* coming motor, and not only the coming motor, but that it has already come, and is driving out the electric, and gas, and other motors, and the steam engine, in England and Germany, and elsewhere in Europe, and that it must soon do so also with us in the United States. But as we look into the operating conditions, we soon find that each of the several motors is most applicable under conditions of its own, and that neither can do all that either of the others can do. Gas and oil, of course, develop power as the steam engine does, while compressed air and electricity can only transmit power that originates elsewhere. But with the development and transmission of power the usefulness of gas ("producer" gas) or of oil ends, while with air and electricity, power transmission is not their only function. Electricity has the vast field of illumination, in which it reigns supreme; compressed air has no one function to compare in magnitude and importance with that of electric lighting, but it has a vast number of duties which are all its own, and which electricity cannot touch. The use of compressed air has been slow of development, and is still backward, but at this writing, I can show a list of two hundred distinct established uses of compressed air, and in more than ninety per cent. of those uses electricity is absolutely inapplicable, and in the remainder, which form a more or less open field to other agencies besides either electricity or air, the air generally has the advantage.

Taken alphabetically, a sample of our list of uses of compressed air is offered, and anyone may judge from it where the competition with electricity comes in:

Acids.—Raising or transferring them by direct pressure, thus avoiding contact with metallic surfaces.

Accumulators.—For hydraulic crane service, dispensing with the enormous weights and cumbrous mechanism formerly employed.

Aerating Bread.—Taking the place of yeast or baking powder, and producing bread light and wholesome.

Aerating Molten Iron.—In the Bessemer process. An application of compressed air in its effects so revolutionary upon the world's industries as to be alone worthy of comparison with the invention of the dynamo.

Aerating Water.—Oxidizing, purifying, and rendering it wholesome and potable.

Agitating Syrups.—In sugar refineries.

Air Brake.—On all the railroads of the world, another revolutionary application of air.

Air Brake.—On street railways, including trolley roads.

Air Refrigerating.—Especially the "dense air" system, used extensively upon ships of war. Fresh meats kept cool by the agency of compressed air are transported from Australia to England.

Air Hoists.

Air Jacks.—Generally meaning air hoists, applied under the load, and also usually portable.

Air Lift Pump.—The "Pohle" pump for artesian wells. Furnishing all the water used in some Western cities.

Air Elevators.

Air Lock Doors.—Opening and closing the doors of air locks in caissons, and in driving soft ground tunnels—an operation distinct from the use of the air in the caisson or tunnel itself.

Applying Hose Couplings.—One day's use of a machine for this purpose paid the entire cost of the machine.

Armor for Divers.—Making the work of the diver an every-day occupation.

Asphalt Refining.

Atomizing Oil for Fuel.—Widely used in metal working, in glass factories, potteries, brick yards, lime kilns, etc.

Atomizing Colors.—Spraying them upon silk ribbons; also upon pottery with novel and beautiful effects.

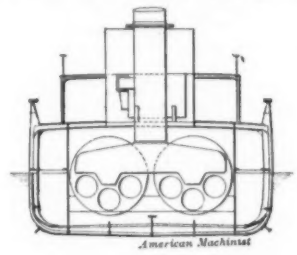
Asphalt Refining.

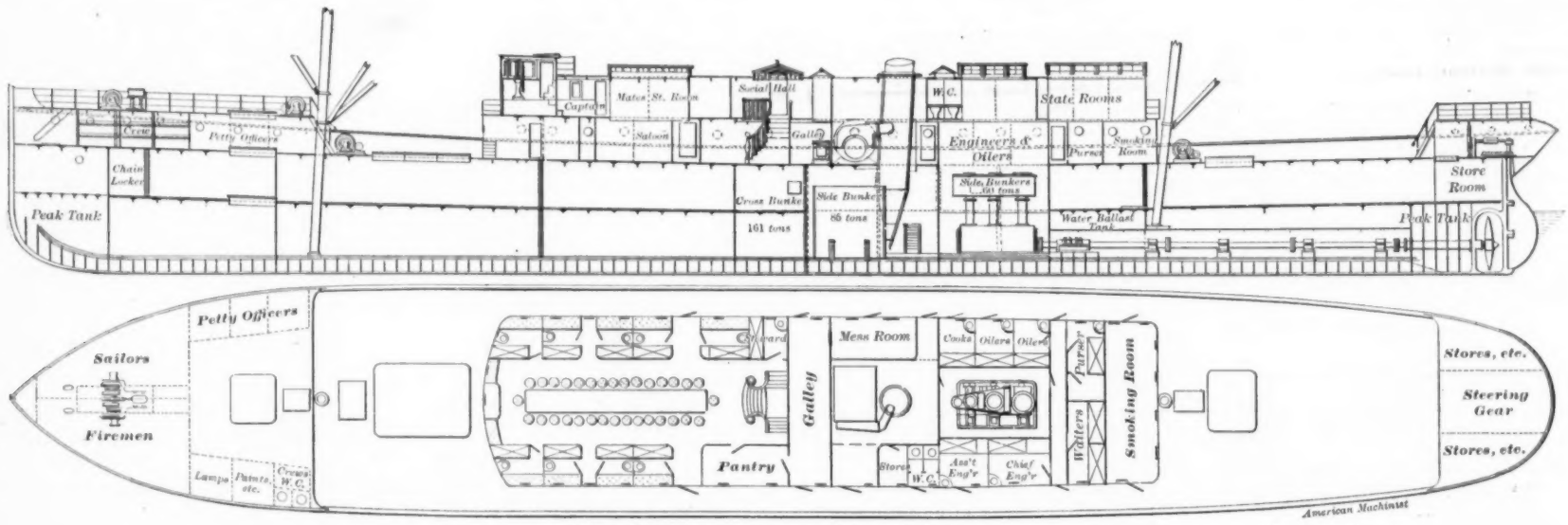
Automatic Pump.—The "Shone" ejector at the Columbian Exposition and elsewhere for sewage disposal.

Automatic Fire Extinguisher.—And various other automatic devices.

In our list of applications of compressed air, of which the above is only a sample, several of the other letters of the alphabet developing a much longer string of them, the uses of air for operating motors, or producing rotary motion in general, or where performing any of the functions of the steam engine, are not included. Referring to the above, it will be noticed that the only applications of air that compete with electricity are the air brake and the air hoist or air jack. The electric brake, in competition with the air brake, is anything but a success, and is not worth further mention. The air jack also has the field to itself, and electricity is "not in it." In the field of general hoisting, air and electricity divide the work, and the line of service done by each is generally distinct from that performed by the other. There are establishments thoroughly familiar with the uses and possibilities of electricity, operating electric traveling cranes, for instance, that use compressed air in numerous places throughout their works for hoisting, and where for the special services electricity would have no chance at all. Where the direct-acting vertical hoist can be used, or the air cylinder, either vertical or horizontal, with multiplying sheaves and a wire rope, it is, of course, preferable to electricity with its drums and gearing. In the general work of hoisting, as carried on at the Armour Packing Company's vast establishment, electricity could not possibly do what the air does.

In the lines of service to which electricity and compressed air seem to be equally applicable, and where they could compete with no apparent disadvantage to either, it is to be regretted that circumstances seem invariably to defeat a fair comparison. In driving pumps a very fair test could be instituted of the relative merits of each, and of the losses in the use of each, as power transmitters, and it happens that in this very work of pumping we find some striking illustrations of what might be termed the constant bad luck accompanying the air, or the malignant opposition of circumstances to any fair exhibition of its powers. Compressed air, by its very accommodating attitude, by its very applicability to widely varying conditions, is constantly placing itself in a false position before the community, and showing itself at a disadvantage. It is able to accept conditions that enable it to make an unseemly and unjust exhibition of its powers, yet which entirely exclude electricity from any such depreciatory performance. The pump that can be operated by electricity can be operated equally well by compressed air, the air motor taking the place of the electric motor, with suitable connecting gearing, and the pumping mechanism remaining unchanged, and under those conditions the air could be made to do better than the electricity. In a certain Western town the water supply is furnished by electrically driven pumps, the pumps being purchased and installed by the town authorities, and the local electric lighting company agreeing to maintain and operate the plant. The current is transmitted about 2,000 feet, and the water is pumped against a constant pressure of 60 pounds. The electric company are to receive 4 cents per 1,000 gallons of water pumped, which is more than twenty times the fuel cost for the same work in the best pumping engines. Electricity could sublet this contract to compressed air at about one-quarter the price, and the air would be greatly inflated over getting the job.





NEW STEAMSHIP FOR THE RED "D" LINE.

Has anyone called attention to the fact that one of our most prominent and perplexing political questions is entirely and indisputably the product of compressed air? Can electricity claim to have contributed any prominent factor in determining the course of parties, or in shaping the destinies of the nation? What if compressed air should be found to hold the balance of power and the deciding voice in the selection of a future president of the United States? This is the actual situation, and not an absurd or exaggerated statement of it. The only political position attained by electricity is that of public executioner. Electricity and compressed air stand to each other as the masked and nameless headsman and Warwick, the kingmaker. The silver question, whichever side of it we may find ourselves upon, is entirely the outgrowth of the increased output of silver, and that, no one can deny, is what the air-driven rock drill has accomplished. The precipitation upon us of this vexing question may have been a work of questionable beneficence, but the power that could achieve it is not to be treated lightly.

Electricity seems to be making advances more rapid than ever before in its employment for railway propulsion. It drives the horses from the surface roads, and is now beginning to supersede the steam locomotive. Perhaps all do not realize that this is the triumph of the steam engineer more than of the electrical engineer. Electricity is demonstrating not so much its superiority as a power transmitter, but simply the ultimate economy of generating power in large central plants, even if the means of distribution is a wasteful one, and accompanied by features that are insurmountably objectionable. The extending use of electricity as a railway motor is an argument also for compressed air, for it, too, is able to take full advantage of the economy in power development, and we are in the way to see very soon some practical demonstration of its abilities in this field. In railroad service, as in everything, compressed air has been heretofore unfortunate, and its advocates have wasted time and opportunity in developing minute economies in the air motor that were not needed to enable it to compete with the best in the field.

New Steamship for the "Red D" Line.

With this we give two sections and a plan of a new steamship which is to be built at the works of Wm. Cramp & Sons, Philadelphia, Pa. This vessel will be added to the fleet of the "Red D" line, of which Messrs. Boulton, Bliss & Dallett are managing owners, and who intend to use this boat for their trade between New York and Maracaibo. In order to cross the bar at the latter port, the draught is limited to 10 feet only, which will enable the vessel to carry about 900 tons dead-weight. The gross tonnage will be about 1,500 tons; the speed is expected to be 11 knots, and 12 knots on a trial of 4 hours' duration, which will place her in the fourth class of the U. S. Ocean Mail Service.

The engine will be of the triple-expansion type, with cylinders 18, 28, and 45 inches diameter, 30 inches stroke. The boilers will be steel, built for a working pressure of 160 pounds per square inch. A donkey boiler will furnish steam for all auxiliary purposes. All the pumps will be independent.

The hull is to be of steel, with a steel deck for half the length of the vessel amidships; there will also be a steel deck house, containing passenger accommodations, a forecastle for the crew, and turtleback aft, all as shown on the plans. The vessel will have five water-tight bulkheads; also a water-ballast compartment aft of engine, and one at each end of vessel; the total capacity of these compartments will be about 200 tons. The dimensions of hull are: Length between perpendiculars, 248 feet; beam molded, 38 feet; depth molded, 17 feet 5 inches. Special attention will be given to lighting and ventilating the passenger accommodations so as to secure the greatest comfort under all conditions, particularly in warm weather.

The plans for this vessel were furnished by John Haug, consulting engineer and naval architect, 206 Walnut place, Philadelphia, Pa.

The Wheelock Engine Co., of Worcester, Mass., whose cylinder-boring system we recently illustrated, has been reorganized as the American Wheelock Engine Company. Edwin S. Cramp, of Philadelphia, is president of the new company, and the vice-president, Alfred H. Hoadley, of Chicago. Jos. H. Hoadley is secretary, and E. K. Hill, of the old Wheelock Company, will be general manager. It is understood that as a result certain patents can be used together, both on marine and stationary engines, that could not previously be so used.

Manistee Improved Steam Pump.

The accompanying illustrations represent a new steam pump recently designed by R. L. Frost, M. E., and manufactured by the Manistee Iron Works Co., of Manistee, Mich. The inventor has had a great deal of experience in designing and constructing steam pumps, being also the inventor of what is known as the Frost pump, and this Manistee pump he considers to possess several new and valuable features.

Fig. 1 shows the general appearance of the boiler-feed pumps. Pumps for other purposes have the same special features, although the general appearance may vary. The steam chest is placed on the side of the steam cylinder, and the ports run to the bottom of the cylinder as shown in Fig. 2; this causes any condensation from the steam to be automatically ejected with the exhaust at each stroke, thus doing away with the necessity for pet cocks. On this account when the pump is set to run at a certain number of strokes per minute it will continue to run at that speed without any care to draw off the condensation, which in most pumps would cause them to slow down if not attended to when running slow.

Fig. 3 shows a cross-section horizontally of the steam cylinder with the valve in position, as when admitting steam to drive the piston to the right, and Fig. 4 shows the vertical section through center of pump. The steam is admitted to the pump at *V* and passes through ports *P* and *P'*; thence through port *M* in valve; thence through ports *S* and *N* into left-hand end of steam cylinder *A* at bottom. Each end of the cylinder is exhausted, respectively, through the ports *N* and *N'* into the exit port *O* through the exhaust cavity, or reduced central portion of steam valve.

There is only one steam valve, and this valve has no mechanical connections with other moving parts of the pump, but it is actuated by live steam passing through the passage *F* in the trip tube *Y* and crosshead and hollow piston rod and thence into groove *I* around piston; when this groove reaches the proper point near the end of stroke it passes over a small port *H*, which allows enough steam to pass into the steam chest to trip the steam valve and reverse the stroke. This arrangement gives the pump a positive full stroke, as it cannot reverse until the piston reaches the end of stroke so as to allow the steam to pass through the port *H*.

The tappets *T* are only for use in starting the valve should it refuse to move when steam is first turned on, because of cold water in the steam pipe or other cause.

The steam valve is also a perfect automatic governor, regulating the steam admitted.

The governing element of the steam valve is in the steam-cushioning chambers *W''* and *W'''*. While valve is passing from left to right a portion of live steam from port *P'* enters the chamber *W''* through a reduced portion of valve body near the head *K*, and is confined in said chamber and compressed by the pressure of steam in chamber *W* on the larger area of the outer end of valve head *K'*.

When the steam piston *C* meets a higher resistance, the pressure of steam driving the same is correspondingly augmented, and the cylinder being connected to chamber *W* by the port *H*, the pressure in said chamber is likewise augmented, which tends to move the valve further to the right and open the steam port *M* further and increase the flow of steam to the cylinder, and at the same time compress the confined steam in inner end of chamber *W''* to a very high pressure.

When the resistance to the steam piston is lessened the pressure of steam driving it will be correspondingly reduced, and the compressed steam in chamber *W''* is allowed to force the valve to the left, reducing the opening of port *M* to the proper size to admit only enough steam to drive the piston against the reduced resistance.

By this arrangement the supply of steam is automatically increased or reduced to suit the resistance, which causes the pump to run at a uniform speed under all conditions and to reverse quickly, quietly, and without jar or vibration, and also makes it impossible for the pump to run too fast or strike the heads, even should the supply to the suction suddenly give out, or the load be suddenly taken off while the throttle is wide open.

The steam valve does not reciprocate rapidly while admitting the steam, as it does in some makes of steam-actuated pumps, but makes one movement of sufficient length to give the proper steam port opening to suit the load, and stands there until reversed for the return stroke. This fact, together with the fact that the valve has only its own weight bearing it against the face, makes the valve very durable. There are no inside packed stuffing boxes, but all are outside where they can be easily looked after and kept tight.

The water cylinders are made either with or without brass linings, and are so arranged that brass lining can be put in at any time, if desired. The water pistons are of cast-iron or gun metal, with fibrous packing, or solid pistons water packed, if for pumping hot water.

All parts are made interchangeable, and in case of breakage a new part can be quickly substituted for the broken one. These pumps are made extra heavy and strong, and average 20 per cent. heavier than other makes of similar sizes. They are built in various sizes and for various purposes, by the Manistee Iron Works Co., Manistee, Mich.

Fig. 1.

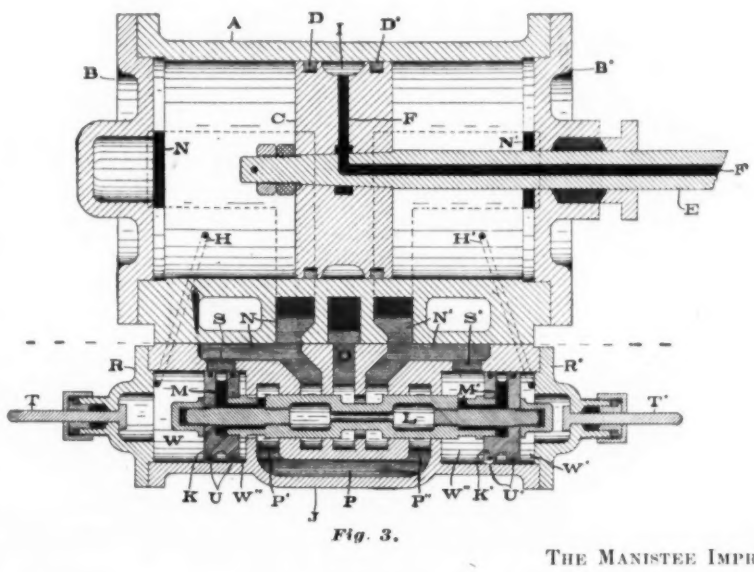


Fig. 3.

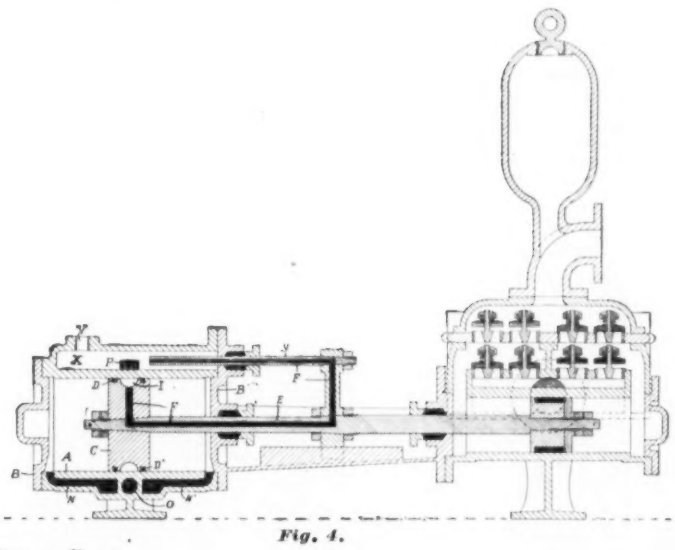


Fig. 4.

THE MANISTEE IMPROVED STEAM PUMP.

A man in charge of a small boiler has had a conflict with one of his numerous bosses. The boiler leaked at one of the fittings and the fireman saved the water and would use it over again. The boss observed this and ordered him to quit it, and finally went to the owner and complained, saying that the fireman was using water that had been through the boiler and "had all the steam taken out of it."—*Unknown Contemporary.*

A Remarkable Armor Plate.

At a trial of a Carnegie 18-inch Harveyized armor plate, conducted at the Indian Head Proving Ground, May 1st, what are claimed to be wholly unprecedented results were obtained. A 12-inch gun was first fired twice at the plate, and then a 13-inch gun firing a projectile weighing 1,100 pounds was used. A press dispatch describes the result as follows:

A 13-inch Carpenter shell, weighing 1,100 pounds, driven by 489 pounds of powder specially adapted to this gun, was discharged with a velocity of 1,810 feet per second in this test. It had the unprecedented striking energy of 25,000 foot-tons, and its impact was only 32 inches to the left of the first shot.

The result was remarkable. It was expected that this test would demolish the plate. A crack 3 inches wide extended some distance from the top, and the shell, after penetrating 10 inches, was, as one of the officers declared, "almost pulverized."

The solid oak backing, however, demonstrated the terrific energy of the projectile, for it was squashed like an accordion, and split into kindling wood.

Upon careful examination the ability of the plate to keep out the heaviest projectile was fully proved by the fact that but one of the fastening bolts was damaged, and the other twenty-five would have held the plate in position on shipboard.

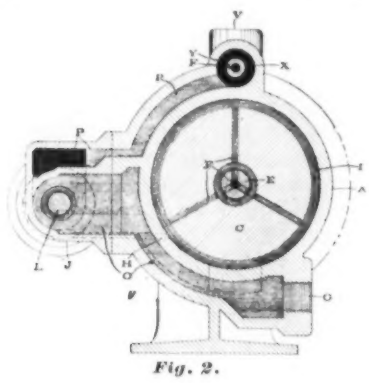


Fig. 2.

This plate is said to indicate that the endless fight between gun and armor, which has recently been rather one-sided in the gun's favor, is now about a tie, and that, with the reforging process, the armor may soon be invulnerable to any existing weapon.

The plate was 16 feet 9½ inches long, 7 feet 3 $\frac{13}{16}$ inches wide, weighed 79,300 pounds, and cost about $20,000. It represented some of the armor plate for the battleship "Oregon" which is being built at San Francisco.

The Acme Standard Screw Thread.

Mr. A. Handy called recently, and said the indications then were that the proposed "acme standard screw thread" would be quite generally adopted and used in place of the great variety of bastard threads now used, and that it would also supersede the square thread for many purposes. He says the Brown & Sharpe Manufacturing Co. are making a large lot of the gauges for

grinding the tools, and that there is a lively demand for them. Mr. Handy thinks it should be understood that in presenting this thread for adoption as a standard there was no idea of presenting an entirely new thread, or one that had never been previously used, but merely to secure, if possible, the adoption of a standard thread for the many purposes for which neither the Franklin Institute nor the square thread is so well adapted.

"Years ago," said the old-time machinist, "there was a planer built somewhere in New England (I think New Haven), that was somewhat fancy in design, and amongst its other ornamental features the cross bar joining the housings at the top had a scroll and fancy design upon it, with the words '*Ne plus ultra*.' It was a fairly good planer for those days. There was nothing the matter with it in particular, but one of them that was in a shop where I worked was a little off in the fitting of the clapper-box, and that gave some trouble to the man who ran it. One day as he was having some special difficulty due to this defect, and was not therefore in his usual angelic frame of mind, a shopmate came along and asked what those words meant across the top of the planer. 'Equal to none,' was the answer growled out between the set teeth of the exasperated greaser."

The Lodge & Davis Machine Tool Co., of Cincinnati, are mailing to the trade their "1895 Scratch Pad." Each leaf has, at the top, something designed to benefit the L. & D. Co., while below is a space for the scratching. The bed plate of the pad is a blank order for another, and will bring one when filled out with address and adorned with a one-cent stamp. A pad will be sent on application.

The shoe shipments from Haverhill, Mass., during the week ending May 3d, were said to be heavier than in any preceding week, 11,766 cases having been sent out, exceeding the largest previous record by 802 cases.

The Westinghouse Brake Abroad.

The advantages of automatic continuous brakes in the case of engines running off the line have been repeatedly demonstrated in this country, where the parting of the couplings has automatically applied the brakes, and saved the rest of the train. Even when the train does not part company, many accidents have been avoided by the great retarding power in the hands of the driver in the case of an emergency. An additional instance of this comes from Warragul, Victoria, where the driver of a passenger train, on approaching some points at high speed, observed them to be partly open. He immediately applied the Westinghouse brake, and, though the engine and tender were flung off the rails, the latter being cocked up in the air, no serious injury was caused to the passengers, though one or two complained of shock. The condition of the points, it is stated, was only noticed at some 40 yards before they were reached, and as the train was traveling 30 miles an hour, the result is an excellent testimonial to the effectiveness of the brake, and even more credit is due to the driver for his prompt action.—(London) *Engineering*.

NEW CATALOGS.

We have received from the Bettendorf Axle Co., Davenport, Iowa, their 1895 catalog and price list of Bettendorf's steel wagon gears, which describes and illustrates a wagon gear made of pressed steel instead of wood, and is, of course, a very interesting product.

The Philadelphia Engineering Works, Philadelphia, Pa., send us "Catalog K," which is devoted to air or gas compressors for any pressure and driven by Corliss engines, belt or rope. These include single, double and triple-compressors, with simple or compound condensing and non-condensing engines. The compressors are specially adapted to handling natural gas.

We have received from the Jeffrey Mfg. Co., Columbus, Ohio, a finely gotten up catalog devoted to illustrations and description of the Jeffrey coal mining machines and mine equipments. A number of new and interesting machines are shown, and the catalog will be found of interest to all who have to do with mining operations and with mining machinery.

We have received from the Studebaker Bros. Mfg. Co., South Bend, Ind., the "Studebaker Souvenir," which is a very finely gotten up book, illustrating by half tone and colored plates, a great variety of wagons, carriages, etc., together with views of the large factory in which they are made. It will be found of interest, not only to those who are concerned with the wagon and carriage trade, but to those also who are interested in extensive manufacturing operations.

We have received from the L. S. Starrett Co., Athol, Mass., "Catalog A," which is devoted to gear and milling machine cutters, and contains illustrations with tables of sizes, costs, etc., of a large variety of milling cutters for various purposes, many of which are relieved so that they can be ground without alteration of form. The list includes cutters for gear wheels, twist drills, taps, reamers and for a large variety of other purposes. The company inform us that this catalog is sent to all who apply for it.

MANUFACTURES.

The Massey-Harris Co., at Toronto, Ont., will erect an addition to its plant 10 by 60 feet.

The Terry's Foundry Co., of Terryville, Conn., recently burned, is busy rebuilding as speedily as possible.

The New Departure Bell Co., of Bristol, Conn., is running two gangs—one night and one day—and are behind in orders.

The electric road between Bristol and Plainville, Conn., has been begun, and will be an extension of the New Britain road.

The Forest City Furniture Co.'s factory at Rockford, Ill., burned the 29th ult. The machinery and engine are thought to be a total loss.

The Cullman (Ala.) Cotton-mill Co. has been incorporated, and will build a mill. J. H. Karter is president. The capital stock is $50,000.

A correspondent in Bristol, Conn., says that most of the shops at that place are running full time, and that there is a bright outlook for the coming year.

The David Mfg. Co. has purchased a site at Kankakee, Ill., and will construct a foundry 80 by 300 feet and also a blacksmith shop of the same dimensions.

The Bessonette Cotton Compress Mfg. Co., of Waco, Texas, have increased their capital stock from $1,000,000 to $1,500,000, and will increase their plant.

The Requette River Railroad Company has been incorporated. It will construct a road to run from Tupper Lake village up the Requette River to Axton, N. Y.

The Empire State Electric Forging Co., of Syracuse, N. Y., has been formed with a capital of $300,000. The directors are L. H. Groesbeck and E. D. Woodruff.

The Taunton Locomotive Mfg. Co., Taunton, Mass., report that within the past 30 days they have placed Wainwright feed-water heaters aggregating 8,975 horse-power.

The directors of the Chicago & West Michigan and the Chicago & Eastern Illinois Railroads are contemplating running a road from La Crosse, Ind., to New Buffalo, Mich.

The Long Manufacturing Co., of Cleveland, Ohio, recently formed with a capital of $25,000, will manufacture machinery. The incorporators are E. A. Upstill and J. Stovering.

The A. R. King Mfg. Co., formerly of Jersey City, N. J., moved on May 1st to 532-540 West Twenty-second street, New York City, where the business will be carried on as usual.

A company has been organized in which W. S. Mathias is interested, to build an electric railroad from Danville to Iroquois County, Ill. The line will be over thirty miles long.

The Ingersoll Milling Machine Co., Rockford, Ill., has recently received a number of orders from Europe for milling machines, and it now seems likely that this company will do a considerable foreign business.

The Sessions Foundry Co., of Bristol, Conn., have broken ground for their new foundry plant, which when completed will be one of the finest and most complete in that section of the country. The company will have its own switching engines.

The Link-Belt Machinery Co., of Chicago, Ill., state that they are finding business very good, especially in the line of their standard water-tube safety boiler. 3,000 horse-power of these are now being put into the North Chicago Street Railway Co.'s plant at Hawthorne & Hobbie streets.

The Hyatt Roller Bearing Co., of New York, report business improving, and say that their form of bearing is meeting with good success in Europe. Mr. Chas. Bourdon, a son of the inventor of the Bourdon spring, is interested in it in Paris, and some tests made there show very good results.

The Gates Iron Works, of Chicago, Ill., have built a new machine shop 350 feet long at a cost of $100,000. It is equipped with a 25-ton traveling crane made by the Morgan Engineering Co., of Al-

Crescent Steel Co.

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The Steel so generally used now for Machine Shop Tools.

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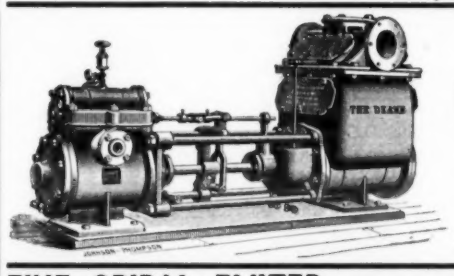

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Ground accurately to gauge.
SEND FOR CATALOGUE.
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Taper 1-2 inch to foot.

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SAVES LABOR in being able to run at GREATLY INCREASED SPEEDS. FEWER GRINDINGS. No WASTE in redressing.
SOLE REPRESENTATIVES IN THE UNITED STATES.
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liance, Ohio, and is operated by electricity and travels the entire length of the building in one minute.

The Berlin Iron Bridge Co., of East Berlin, Conn., are putting up an iron bridge at Thomaston, Conn., consisting of two plate girder spans, each 60 feet long, with a roadway 22 feet wide, and two sidewalks, each 6 feet wide. The bridge will be made entirely of iron and concrete, no woodwork being used in the construction.

Mr. J. H. Dunbar, Youngstown, Ohio, writes us that among recent shipments of his American packing rings, 48 were to the New York, Ontario & Western Railway Co., this being its fifth order. There are also 48 rings to the Delaware & Hudson Canal Co., and 12 to the Pultney Foundry and Engineering Co., of Youngstown, Ohio.

Mr. Jas. J. Pearson has taken out of the hands of Nassau Electrical Co. the business of manufacturing and selling the Capo-farad battery and other electrical and mechanical goods and supplies, and will conduct the business under the name of The Capo-farad Battery and Appliance Works, corner Thames and Greenwich streets, New York, N. Y.

Messrs. Chess, Wymond & Co., of Louisville, Ky., one of the largest cooperage establishments in the United States, are erecting an additional building to their extensive plant for the purpose of putting in a machine shop in which to do their own repairing. They have contracted with The Lodge & Davis Machine Tool Co., of Cincinnati, Ohio, for the equipment of this shop including lathes, shapers, etc.

Mr. Daniel C. Stover, president of the Stover Bicycle Co., Freeport, Ill., which manufactures the Phœnix bicycle, states to our correspondent that his company is far behind with its orders, and that the factory, which is now being pushed to its utmost, will be enlarged as soon as possible with a view to making 10,000 Phœnix bicycles next season. It is Mr. Stover's intention to be closely identified with the company in the future.

Machinists' Supplies and Iron.

NEW YORK, May 4, 1895.

Iron—American Pig—We quote standard brands, $12 to $12.50 for No. 1; $10.75 to $11.25 for No. 2; and $10.25 to $10.50 for No. 2 Plain. Southern brands, $11.25 to $11.50 for No. 1; $10.75 to $11 for No. 2; $10.50 to $10.75 for No. 3; $10.75 to $11 for No. 1 soft; $10.50 to $10.75 for No. 2 soft; and Foundry No. 4, $10 to $10.25.

Antimony—The market remains unchanged. We quote L. X., 8¼c. to 8¾c.; Cookson's, 8¼c. to 8¾c.; Hallett's, 7.10c. to 7.15c; U. S. French Star, 7¾c., and Japanese, 7c.

Lard Oil—Prime City we quote at 54c. to 55c.

Copper—The market is very firm and prices have advanced. The demand is strong and considerable business has been done. Lake Copper has been sold at 9.75c. to 9.85c., but some holders are now asking 10c. Casting Copper is held at 9¼c. to 9⅝c.

Lead—The market is quiet with no change in prices. For New York delivery 3.07½c. is quoted.

Holders are more free in their offers, but there is no pressure to sell

Spelter—The market is dull, but the prices are firm at 3.28c. for New York delivery.

Tin—The market is steady, and dealings with the home consumers have been fully up to the average. For prompt and current month delivery 14.20c. is quoted.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Wanted—Agents traveling and local to sell steam spec's; good commission. Mfr., 1115 State St, Erie, Pa.

Head draftsman on tools & gen'l mach'y will take any position. A1 references. T., AM. MACHINIST.

Engineer & draftsman (Scotch) wants position; 20 yrs. exp.: marine & general. Box 180, AM. MACH.

Wanted foremanship, by one having a wide experience with general jobbing; generators, dynamos, and engines. Indicator, care AM. MACHINIST.

Wanted—Situation by experienced machinist and tool maker, as gen'l foreman or sup't.; best of refs. P. F. Schroder, P. O. Box 253, St. Joseph, Michigan

Draftsman (23) desires change of position; tech. education; shop experience; A1 references; New England concern preferred. G. T., AM. MACHINIST

Wanted—Intelligent, responsible men acquainted with high-class mechanics and inventors; no canvassing. Edwin Guthrie, Washington, D. C.

Practical machinist and draftsman, 25 years' experience in large scale works as foreman and master mechanic, desires change; large exp. in special mach. and jigs to reduce cost. E. H. W., AM. MACH.

Graduate of leading technical school, 4 years' experience in shop, 2 years in drawing office, desires change—could invest $1,000. Address Box 175, care of AMERICAN MACHINIST.

Wanted—Foreman for a machine shop employing 50 to 75 men; must be thoroughly posted in modern machine shop practice and a hustler; no other need apply. Address T. M., AM. MACHINIST.

Mechanical engineer and draftsman, large practical experience in design & construction of power plants, wants position as sup't or otherwise; highest references. Address Practical, AM. MACHINIST.

Wanted—A steady reliable machinist-blacksmith to work in Vermont country town; good pay and steady work for satisfactory man. Address (with experience) A., care of AMERICAN MACHINIST.

Wanted—By up-to-date foreman & manager who will guarantee standard work at lowest cost of production, a position with some enterprising manufacturer who will appreciate ability and integrity. Address No Novice, care of AMERICAN MACHINIST.

Wanted—Position as draftsman, by young machinist with tech. education and moderate drawing office exp.; clear draftsman and practical designer; used to engs. or pumps. Box 181, AM. MACH.

(*Continued on Page 374.*)

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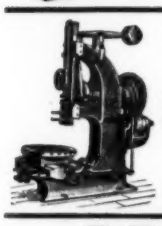

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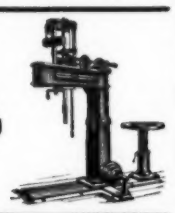

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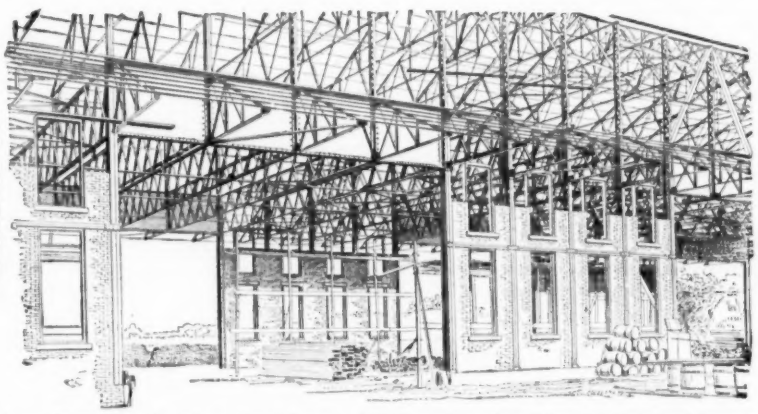

Iron and Steel Bridges and Buildings.

The above illustration is taken direct from a photograph, made during the construction, and shows the details of an Iron Building designed and built by us for the Newport News Ship Building and Dry Dock Co., at Newport News, Va. The building is 60 feet in width by 320 feet in length, and is two stories high—the lower floor being used as a Ship Shed for punching, bending, riveting, etc.—the upper floor being used as a Mold Loft. Outside of the building, extending entirely around it on all four sides, is an overhang 12 feet wide, thus affording additional shop room outside of the building, where raw material may be stored and still be protected from the weather. Wide openings are placed every 40 feet so that raw material may be taken in, and finished product moved out, cheaply and quickly. The supporting frame is all iron throughout, and between the iron posts on the sides is a light brick wall.

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CHICAGO OFFICE:
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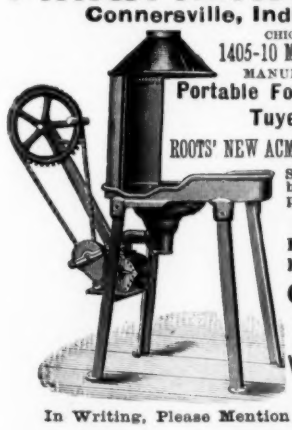
MANUFACTURERS OF
Portable Forges,
Tuyere Irons, Etc.



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Any size or style. Spur, Bevel, Spiral, Ratchet, Worm, Rack, Elliptic, Internal, etc. Small or large.
Send for Catalogue. 1,100 sizes of Gears.

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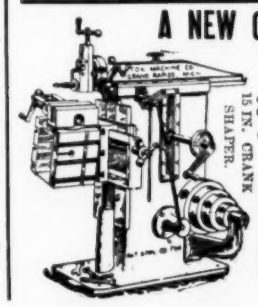

15 IN. CRANK SHAPER.
NOVEL, YET SIMPLE.
Length of stroke changed INSTANTANEOUSLY while IN MOTION.
Get Photos & Prices.
NOTHING LIKE IT.
Fox Machine Co.,
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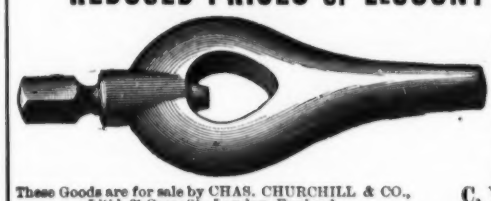
REDUCED PRICES OF LeCOUNT'S STRAIGHT TAIL DOG.



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No.	INCH.	PRICE.	No.	INCH.	PRICE.
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2	⅞	.70	11	2¾	1.45
3	1	.70	12	3	1.60
4	1⅛	.80	13	3⅛	1.80
5	1¼	.80	14	4	2.10
6	1⅜	.95	15	4½	2.75
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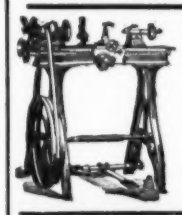
1 Set to 2 In.		7.80	Full Set.		$1.10

These Goods are for sale by CHAS. CHURCHILL & CO., L't'd, 21 Cross St., London, England.
C. W. LeCOUNT, South Norwalk, Conn.



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9 and 12 inch Swing.
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We make a vise for holding small or irregular shaped pieces while drilling. The work can't slip. You break no drills. Write us.
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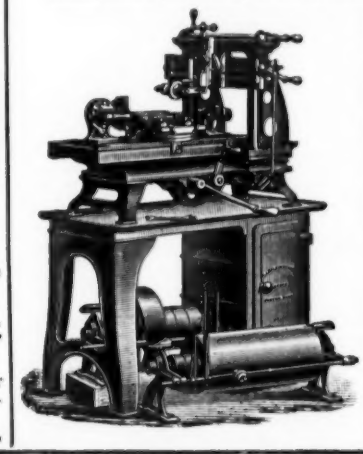

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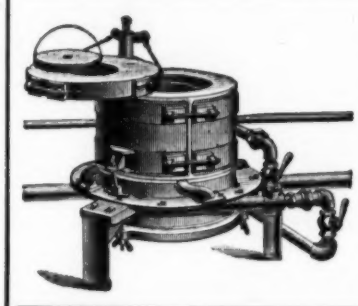

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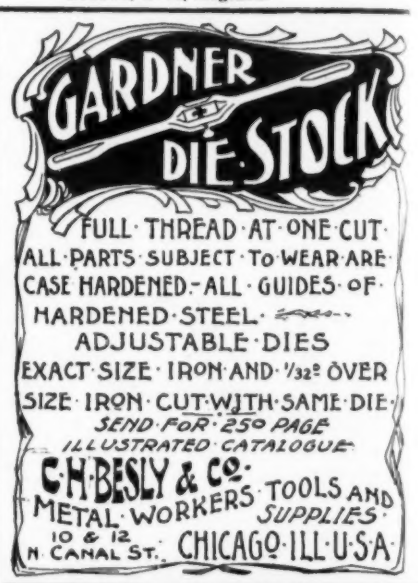
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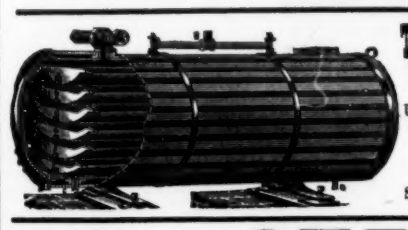

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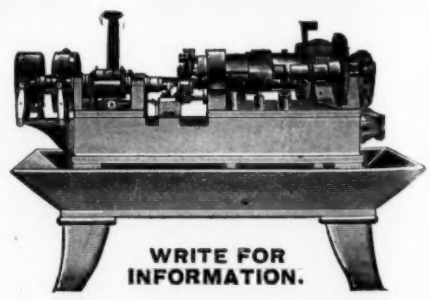

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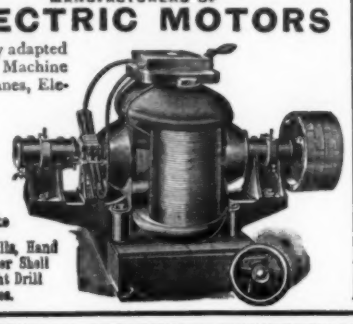

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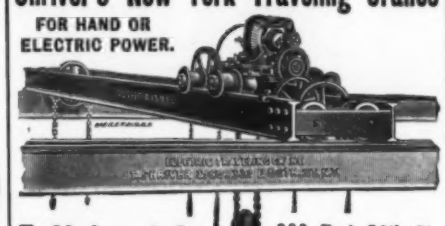

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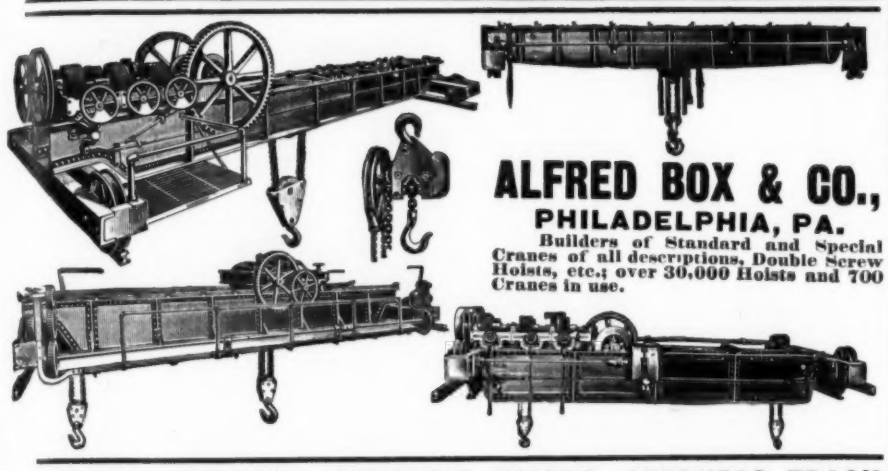

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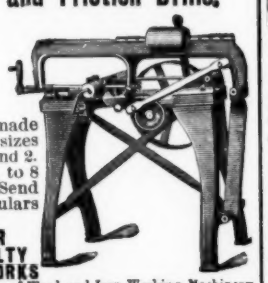

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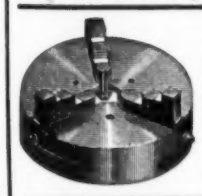

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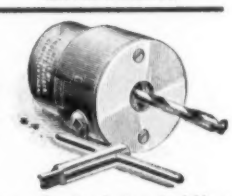

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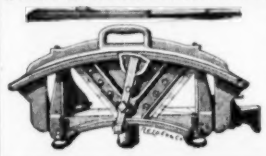

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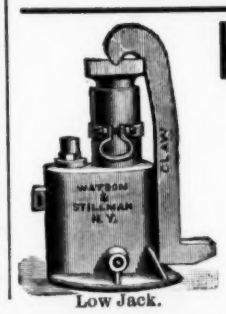

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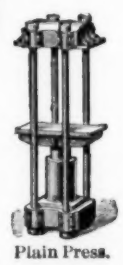

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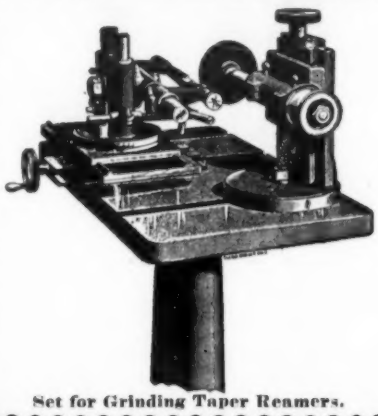

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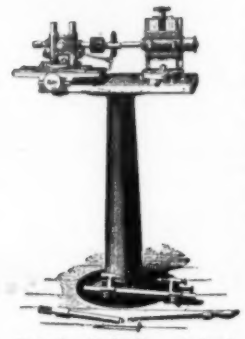

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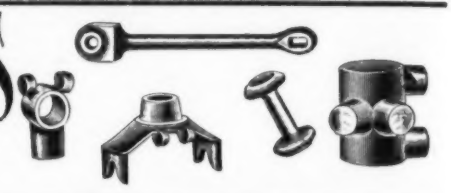

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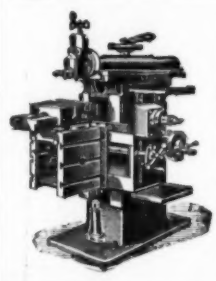

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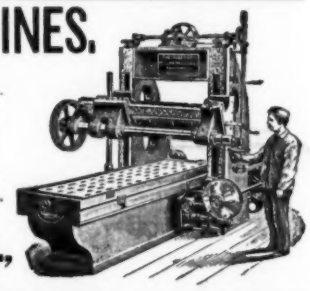

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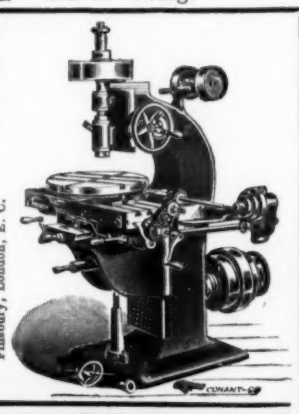

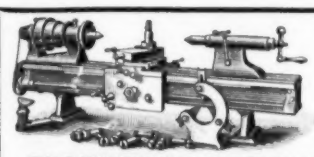

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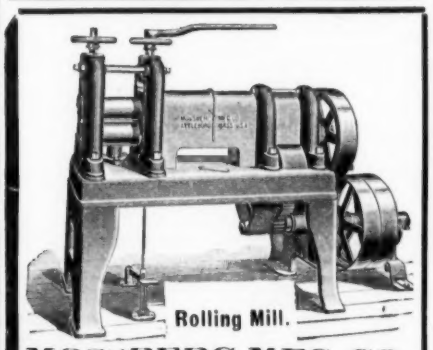

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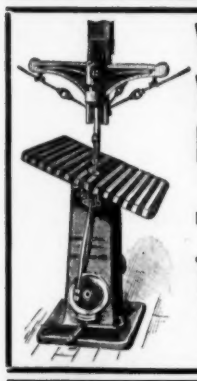

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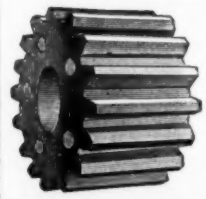

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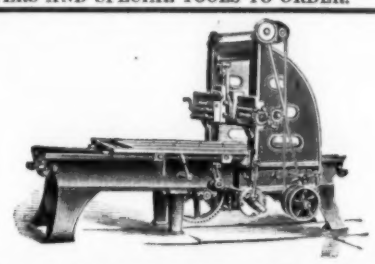

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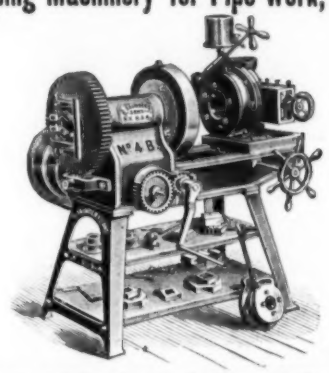

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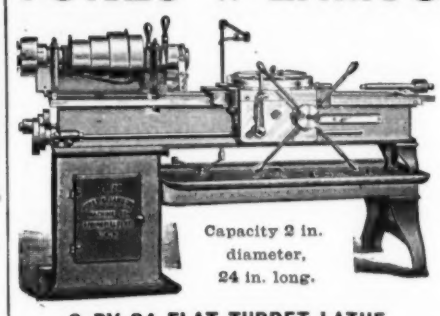

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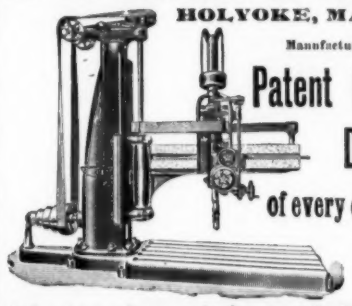

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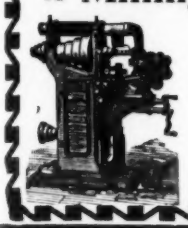

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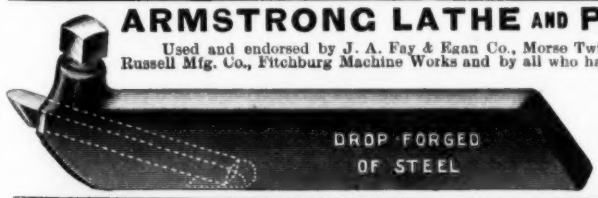

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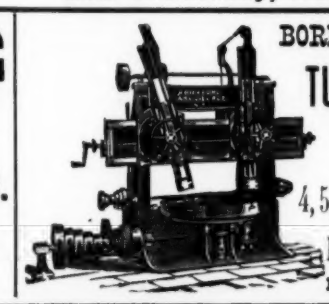

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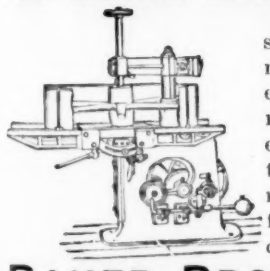

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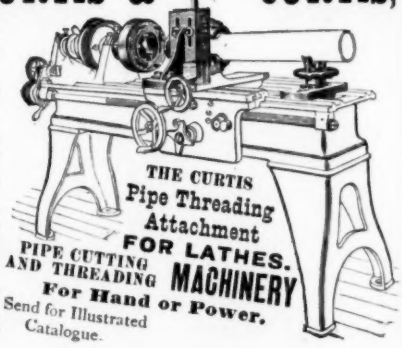

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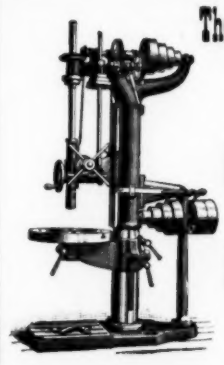

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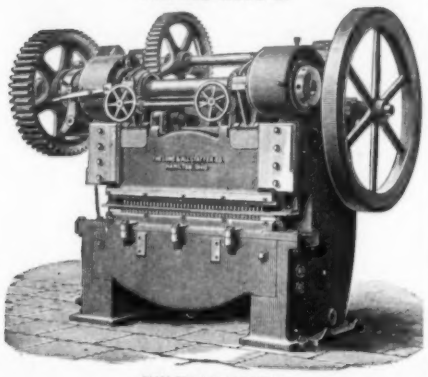

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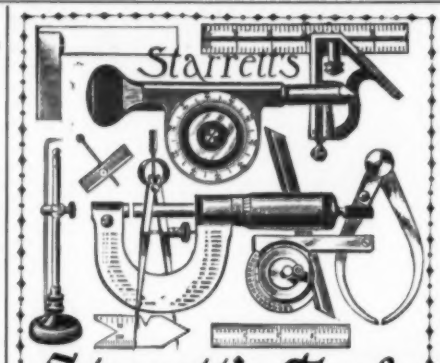

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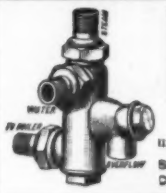

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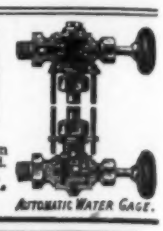

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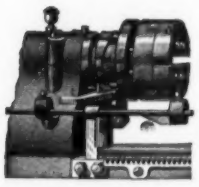

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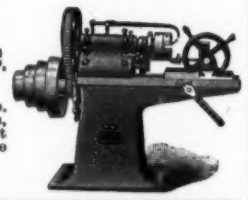

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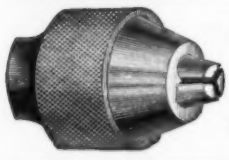

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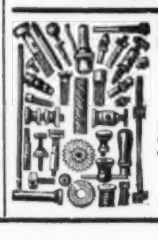

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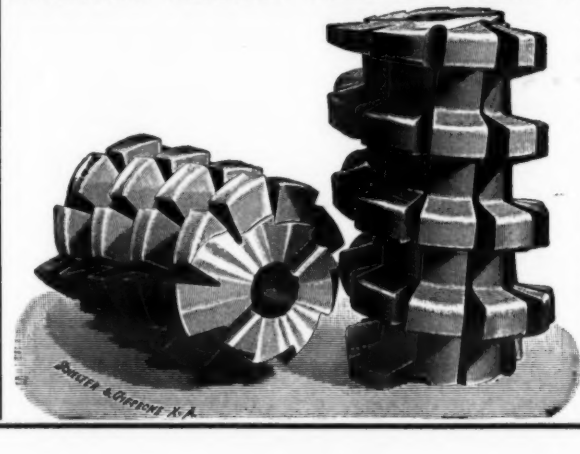

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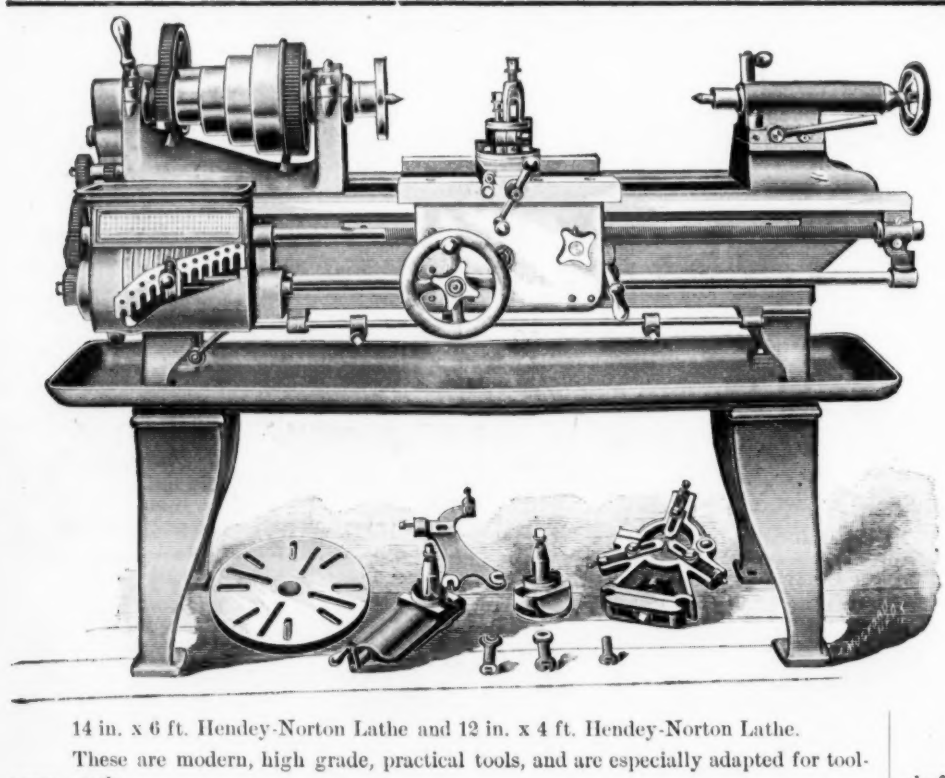

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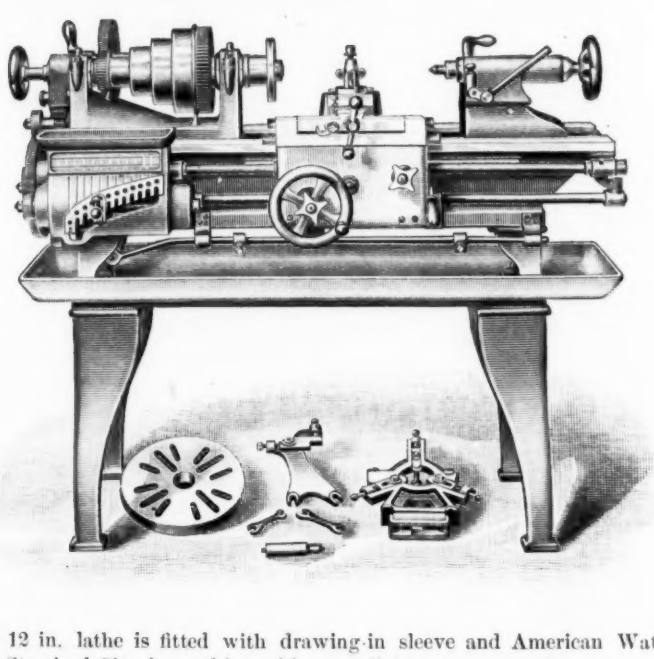

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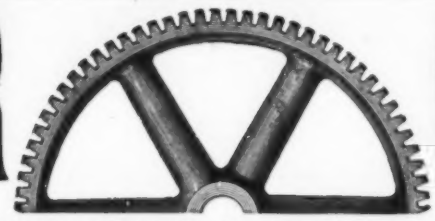

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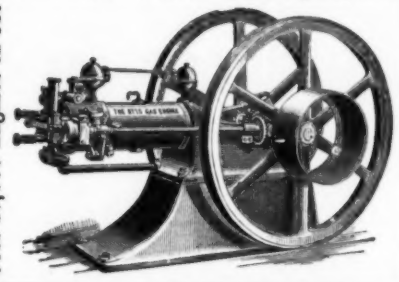

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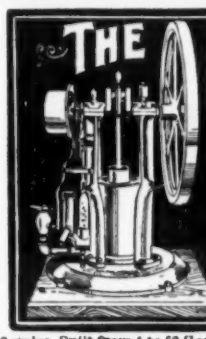

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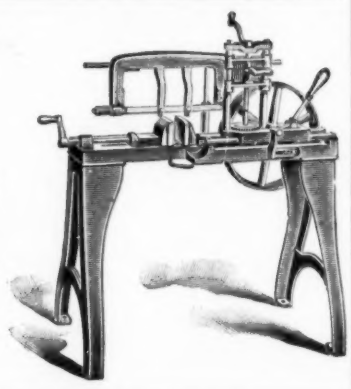

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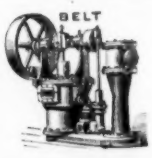

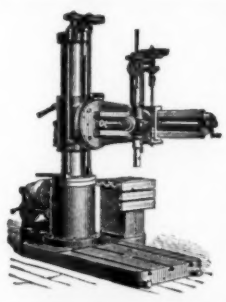

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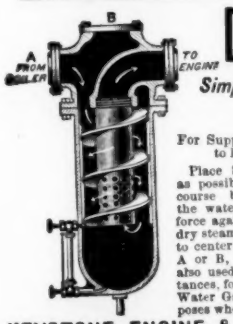

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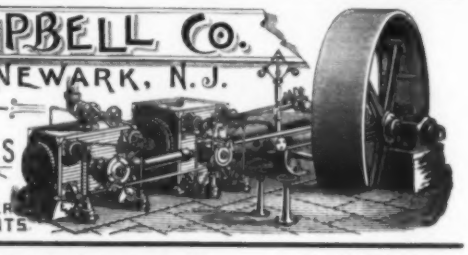

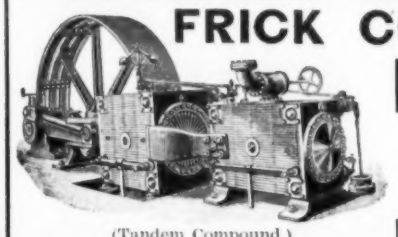

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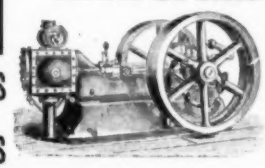

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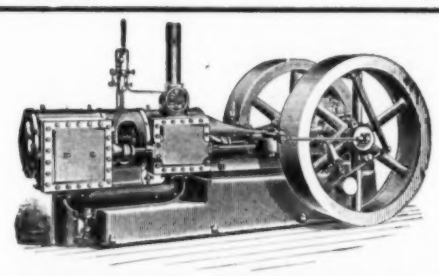

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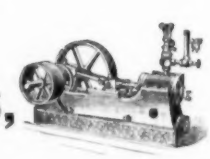

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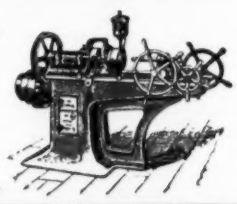

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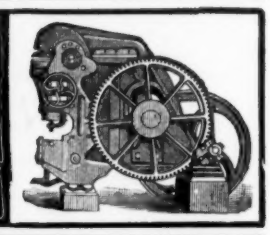

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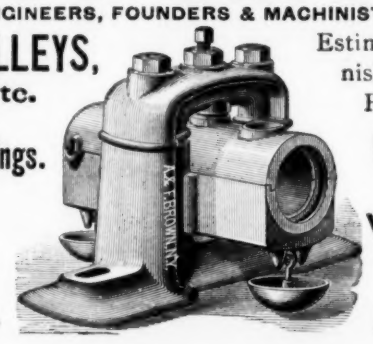

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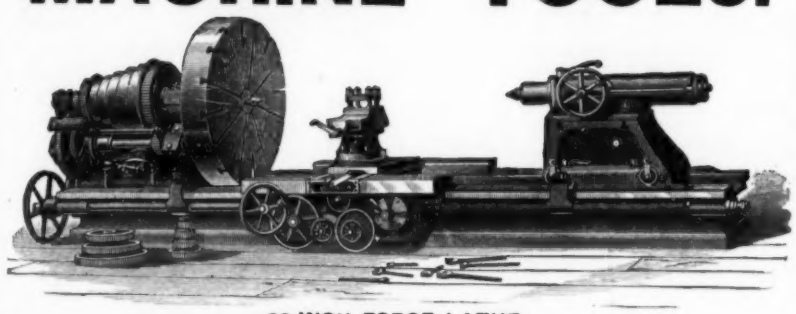

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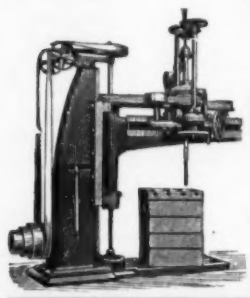

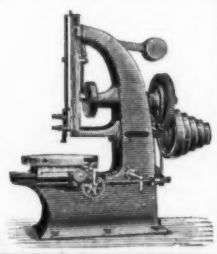

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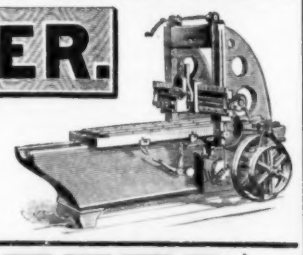

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1 No. 3 screw machine, back geared, 1 11-16 in. hollow spindle and power feed.
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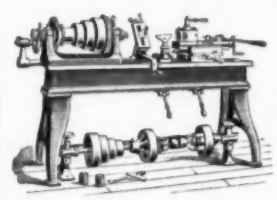

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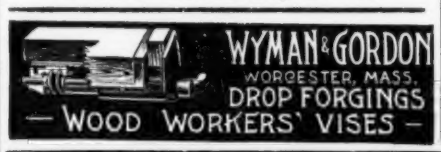

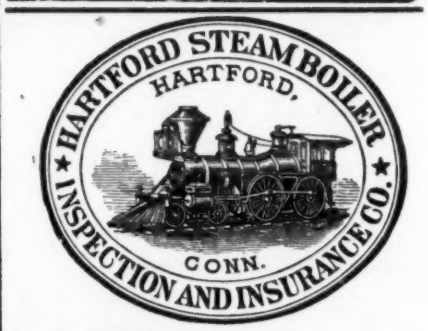

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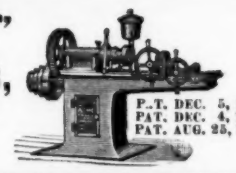

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12", 14", 16", 18", 20", 24", 27" and 30" swing. Also
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